Chapter 3

Ian Drew/USFWS

Vernal pool

Affected Environment

Introduction

This chapter describes the physical and socioeconomic settings of the refuge in both a regional and local context. We first describe the regional landscape, including its historical and contemporary influences. Next, we describe the refuge and its resources in a local context.

The Upper Androscoggin River Watershed and the Northern Forest

The Landscape Setting

The refuge lies in the Upper Androscoggin River watershed, in a broad valley near the rugged White Mountains, where dozens of peaks rise more than 3,500 feet in elevation. Mount Washington lies to the south at 6,288 feet. It is the highest peak in the Northeast (Publicover and Weihrauch 2003). These lands, clothed in trees, are part of the 26-million-acre region known as the Northern Forest, which stretches from eastern Maine through northern New Hampshire, Vermont, and New York (Northern Forest Lands Council 1994).

Maine and New Hampshire are the most heavily forested states in the Nation, and the Northern Forest one of its largest contiguously forested regions. Those forests, waters, and wildlife profoundly influence the culture and economies of the northern reaches of the two states. The refuge lies in the transition zone between the vast spruce-fir, boreal forests of Canada and the maple-beech-birch northern hardwoods to the south. That mixing of forest types, combined with the rugged terrain, diverse geology, and myriad lakes, bogs, and other wetlands supports a richness of flora and fauna (Dobbs and Ober 1995).

The Northern Forest produced more timber than any place in the world during the 1800s (Dobbs and Ober 1995). Until the 1980s, nearly 85 percent of the Northern Forest was privately owned: much of that by large paper companies. The culture of the region is rooted in the traditions of hunting, fishing, and working in the woods. By the 1980s however, 75 million people lived within a day's drive of the region, and the expanding global economy was putting pressure on the large commercial landowners. In 1988, 1 million acres of land formerly owned by Diamond International Corporation went on the market. That marked the beginning of major shifts in land ownership patterns that continue today (Northern Forests Lands Council 1994).

The Historical Picture

Glaciation

The Earth has experienced several glacial periods; the last, known as the Pleistocene Ice Age, began about 2 million years ago. Glaciers advanced and retreated over time as temperatures fluctuated. The most recent period to affect Northern New England was the Wisconsin Glaciation, which reached its maximum extent about 18,000 years ago. A one-mile-thick sheet of ice, known as the Laurentide Ice Sheet, covered the region until its retreat from the Upper Androscoggin River watershed 10,000 years ago.

As glaciers retreat, they leave behind piles or layers of sediments, rocks and other debris known as glacial drift. These surficial deposits over bedrock come in two types in our region: glacial till and glacio-fluvial. Glacial till is a mixture of sand, silt, clay, and rock ground up by the glacier and dropped as it retreated. It covers most of our region, deepest on lower slopes, and thin or absent on mountaintops and ridges. Glacio-fluvial drift develops from the transport, sorting, and deposit of material by flowing glacial meltwater. Larger gravels and stones settle out at higher gradients, while finer silts, sands, and clays settle out at as the waters slow at valley bottoms (Sperduto and Nichols 2004).

After the Ice Age

Ten thousand to 12,000 years ago, the retreating ice sheet scraped and molded the valleys, slopes and mountaintops, leaving behind a landscape bare of

vegetation. However, at the southern edge of the glacier, plants survived and immediately began to re-colonize the newly exposed soils (Marchand 1987). Large mammals, including mastodons, wandered the spruce parkland and grassy savanna, but disappeared quickly at the same time as the glacier receded and humans advanced across the region. Thirty-five to 40 large mammal species became extinct 9,000 to 12,000 years ago, while other mammals that were around then, such as timber wolf and white-tailed deer, are still present today (Pielou 1991; Askins 2000).

Continual weathering and erosion of rock over time released nutrients and created new soils for plants to grow. Sedges and dwarf shrubs dominated the tundra-like landscape for several thousand years. As the climate warmed, these plants and animals followed the glacier as it receded north. The tundra continued to retreat, eventually restricted to the highest mountaintops (Davis 1983; Marchand 1987).

Hardwood and softwood tree species advanced independently of one another, creating different forest communities through time (Davis 1983). Graham (1992) reported a similar individualistic response by mammals to the post-glacier climate changes. Spruces were the first trees to colonize, nearly 2,000 years after the ice melted. Pollen records show balsam poplar and dwarf birch in the mix with spruce (Davis 1983). The sequence of plant species arrivals as the glacier receded was different at different sites (Davis 1981). In Northern New England, northern hardwoods—American beech, sugar maple, and yellow birch—established their dominance 2,000 years ago, while spruce regained dominance on the middle slopes, following an earlier dieback (Davis 1981, 1983; Marchand 1987; Pielou 1991).

Native People

Evidence from archaeological sites in the region documents human habitation in the Umbagog Lake area as far back as 11,000 years ago (Hanson 1996). Those early inhabitants traveled along the region's waterways and camped at numerous sites along headwaters of the Androscoggin River watershed (Hermes and Pollock 2001; Gramly 1982, 1984). Native American influences on the spruce-hardwood forests of northern New Hampshire, however, were thought to be minor compared to those of indigenous populations further south. They used fire to clear land for agriculture, improve habitat for game, or facilitate travel through the forest in the drier hardwood forests of southern New England (Cronin 1983). The more sedentary, concentrated populations in coastal southern New England likely set repeated fires that had a more lasting impact on the landscape. In interior and northern New England, native people were more mobile, traveling by boat rather than on foot, gathering food from rivers and the sea rather than by farming, and rarely using fire. Wild foods, including fish, game, roots, and berries were abundant, and the local climate was unsuitable for growing crops (Patterson and Sassaman 1988).

Human Land Use Last 200 Years

Farming, harvesting timber, building dams, and developing land are the primary forces that have shaped the Upper Androscoggin River watershed region in the past 200 years.

The first explorers did not reach this region until the 1780s. Early pioneers arrived in Errol in 1806, and by 1831 there were enough inhabitants to hold the first town meeting (Annis et al. 1999). The first residents settled along the river, where they cleared land for agriculture. Many families brought cows, sheep, and pigs from their previous homes, and needed to raise feed for the livestock as well as grain for their own use (Littlehale et al. 1975).

Agriculture remained the primary land use of the fertile floodplain soils well into the twentieth century, as evidenced by the presence of open fields in the major valleys today. Horse logging required hay and grain to maintain the logging company teams from the late 1800s into the 1930s, when diesel engines began to

take over. Dairy herds were introduced during the 1940s, but many farms were abandoned as people sought other work (Annis et al. 1999; Littlehale et al. 1975), and some of the agricultural lands have reverted to forest.

Timber harvesting
In the 1820s, commercial logging began in earnest as mills were built in the towns along the Androscoggin and Magalloway rivers to facilitate the transport of logs. Early loggers used hand axes and crosscut saws, skidded the logs using horses, and floated the logs to the mills on the rivers. That was the typical practice until the Great Depression in the 1930s. Thereafter, chain saws, motorized skidding, and overland hauling of logs replaced axes, horses, and most of the river drives. The railroad arrived in Gorham in 1851 and in Berlin in 1855. The last long-log river drive on the Androscoggin River occurred in 1937, although pulpwood was moved downriver until the early 1960s (Publicover and Weihrauch 2003). The boom piers visible in the river north of Berlin are stone and wood structures used until the mid-1960s by the two large paper companies, International Paper Company and Brown Company, to separate their respective logs traveling downriver. The boom piers were also used to separate long lumber logs from the shorter length pulpwood (Northern White Mountain Chamber of Commerce, 2005).

White pine was harvested for local building material and, eventually, for export downriver. Those trees, up to 7 feet in diameter, grew abundantly along the shores of lakes and rivers (Wood 1961). The New Hampshire Legislature chartered a toll dam in Errol in 1837, and incorporated the Androscoggin Boom Company in 1851 to control the rafting of pine logs down the river. The use of red spruce for lumber began in 1845 on the Penobscot River, and spread to the headwaters of the Kennebec in 1850. Although not as massive as the pines, spruce trees grew to diameters of 2 feet. The abundant spruce of the Magalloway region impressed the crews surveying the Maine-New Hampshire boundary during the 1850s, and the first drive of spruce logs on the Androscoggin River occurred in the 1860s. Other tree species used included hemlock bark for tanning, tamarack for ship knees, northern white cedar for shingles, and balsam fir for boxes (Foss 2003).

The demand for lumber increased dramatically after the Civil War (Whitney 1994). That increased logging pressure depleted the growing stock of large pine, and spruce had become the primary lumber species by the 1890s. The pulp and paper industry began during the 1870s and 1880s, providing a market for smaller diameter spruce trees. The consolidation of family businesses and local cooperatives led to the formation of large industrial logging companies in the late 1890s, and the rate of harvest continued to increase. Berlin Mills Company and International Paper Company began to buy up land and control the harvest in the Androscoggin River valley (Smith 1972). By the first decades of the twentieth century, little virgin forest remained in the Northeast.

Harvesting declined following the boom years of the mid-1800s to the early 1900s, but started up again in the economic expansion following World War II. The early twentieth century saw the emergence of silviculture: the application of forest management principles to the growing and harvesting of trees to sustain a wood flow over time. New and bigger mechanized equipment was introduced to the forest, allowing more trees to be harvested in a shorter time, providing additional flexibility in applying silvicultural practices, and improving worker safety. Today, sustainable forestry and the global economy are the driving, and sometimes opposing, forces behind the timber industry in the Northern Forest (Publicover and Weihrauch 2003).

Dam Building
For hundreds of years logging has been a central part of the region's economy. Prior to the mid-1800s logs were floated downriver without the aid of dams to

control water levels. Log drives were limited to spring flood events and took up to four years to reach their destination. The desire to move logs more quickly led to the first dams built on the Rangeley Lakes by the mid-1800s. The power of flowing water aided the onset of the Industrial Revolution. Greater demands for power led to rebuilding the dams to allow larger volumes of water storage. Union Water Power Company incorporated in 1878 and took over management of the dams in the Rangeley chain of lakes with an interest in power generation. Today, water flows are regulated to generate electricity for paper mills and other uses, control the impacts of flooding, create recreational opportunities, and manage community wastewater treatment systems (FPLE undated).

Errol dam

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The first dam in the Upper Androscoggin River watershed was built in 1836 on Rangeley Lake. Over the next 75 years, several more dams were built on the lakes and rivers in the watershed. The major water users of the time signed an operating agreement in 1909 that regulated water flow and storage; the agreement was modified in 1983, and still largely governs the region today. In 1999, FPLE purchased the rights to operate the dams and manage the reservoir storage in the headwaters of the Androscoggin River. They are the current holder of the FERC license for the Errol Project. FPLE regulates water levels through a series of dams on the Androscoggin River (Errol Dam), Lower Richardson Lake (Middle Dam), Upper Richardson Lake (Upper Dam), Rangeley Lake, and Aziscohos Lake (FPLE undated). Map 1-1 includes the locations of major dams on those waterways.

The 1909 Androscoggin River Improvement Company agreement, as it is known, states that the river flow at Berlin should be maintained at "as high a point above the minimum as shall be consistent with proper and economical use of the stored water." FLPE keeps the Berlin flow above 1,550 cubic feet per second (cfs) when possible. In 1998, a cooperative agreement among the power company, state and federal agencies, and conservation groups as part of the FERC license was signed to further guide the water levels and flows specifically to protect fish and wildlife.

Development

The Upper Androscoggin River watershed is still a largely undeveloped region; at least it was until the building boom of the 1980s opened the region to speculators and second home development. In the early decades of settlement, homes were clustered around towns and sparsely scattered along the rivers and lakes. With logging roads and bridges still the dominant features in the forested uplands and hinterlands, development along rivers and lakeshores has steadily increased in the past two decades. In just the past few years, more large landholdings were sold and subdivided, and homes are creeping up the hillsides.

Much of the shoreline of the Androscoggin River south of Milan, New Hampshire, has some low-density rural development, as does the shoreline of Rangeley and Mooselookmeguntic Lakes in Maine. The shorelines of Umbagog, Aziscohos, and Richardson lakes remain largely undeveloped (Publicover and Weihrauch 2003). The spurt of development that began in the 1980s prompted conservation groups to pursue permanent land conservation in the region, including supporting the creation of the refuge (Dobbs and Ober 1995).

Climatic Effects and Natural Disturbances

"It is said that nowhere else at the same latitude in the northern hemisphere is it as cold as in the Northeast, except perhaps in northeastern China and Hokkaido, Japan" (Marchand 1987). The reason for the region's cold climate is partly a result of the pattern of atmospheric circulation in this hemisphere. Low-

pressure systems all converge on New England regardless of their origin, and pull cold Canadian air in behind them as they pass over the Northeast (Marchand 1987). New England weather conditions are influenced more by the North American landmass than by the Atlantic Ocean except along the coastline (Taylor et al. 1996).

Natural disturbances vary across New England, depending on geographic location, forest type, and local conditions. For example, hurricane damage is greater on exposed versus sheltered slopes, lightning fires are more frequent on exposed ridges and on sandy versus loamy soils, and shallow root systems make softwoods vulnerable to wind-throw, particularly on shallow and poorly drained soils.

In general, historically, a gradient of decreasing disturbance frequencies extends from coastal regions to interior uplands and mountains. In pre-settlement times, coastal oak-pine regions likely had >10 percent in early successional forest conditions, while interior northern hardwoods had 1 percent to 3 percent of young forest. The proportion of young forest in spruce swamps and spruce flats may have been as high as 7 percent. Northern hardwood and mixed woods may have higher proportions of early successional stages today than historically, based on disturbance patterns (Lorimer and White 2003).

Native insects and disease, ice storms, droughts, floods, landslides, and avalanches have caused minor and major disturbances. For example, spruce budworm periodically affects millions of acres of spruce-fir forest in northern New England and southern Canada, and the 1998 ice storm damaged forests, particularly hardwoods, across 12 million acres in northern New England (DeGraaf and Yamasaki 2001). Lorimer and White (2003) depict hurricane frequencies as varying from 85 years in southeastern New England, 150 years through central Massachusetts and the southeast corner of New Hampshire, to 380 years or more in northern New England. Lorimer (1977) estimated catastrophic disturbances from fire and wind throw at intervals of 800 and 1,150 years, respectively. In contrast, small gap disturbances were frequent in our forests, and may have occurred at scales smaller than what are currently delineated as "stands" today (Seymour et al. 2002).

Although called "spruce budworm," this native insect has a significant impact on balsam fir during periodic outbreaks that are part of the natural cycle in northern forests. Records dating back to the late 1500s indicate that budworm outbreaks occur on about a 40-year cycle. The last in northern New England occurred in the 1970s and 1980s. Large areas of balsam fir and white spruce are defoliated, followed by high tree mortality, then re-growth and recovery of the forest through seedling and sampling release in the newly opened canopy (Boulanger and Arseneault 2004).

Global climate changes will affect natural disturbance patterns over time (Lorimer 2001). The greatest effects of climate change will be on regional air and water temperatures, precipitation patterns, storm intensity, and sea levels. These effects are predicted to influence natural disturbances by resulting in an increase of freeze-free periods, decreased snow cover and lake ice duration, increased storm intensities and frequencies, increased likelihood and frequency of droughts, damaging ozone, and an increase in the spread of invasive species and disease (NH WAP 2005). The resulting effects on wildlife and habitats are expected to be variable and species-specific, with a predicted general trend of ranges shifting northward. Impacts will likely be most severe for habitats with narrow temperature and water level regimes, such as alpine, high and low elevation spruce-fir forests, coastal islands, vernal pools, and aquatic habitats (NH WAP 2005). The uncertainty about the future effects of climate change requires managers to use adaptive management to maintain healthy ecosystems in light of that unpredictability (Inkley et al. 2004).

Wildlife Changes

Wildlife populations ebb and flow as habitat conditions vary in space and time. Change is inevitable and natural, although human activities in the last 200 years have significantly altered the landscape compared to the previous 10,000 years when humans first colonized the Northeast (Foss 1992).

The 1800's witnessed the demise of many forest wildlife species in New England from the loss of habitat (forest clearing), bounty and market hunting, millinery trade, and natural history specimen collecting (Foster et al. 2002). Mountain lion, gray wolf, elk and caribou were extirpated by the mid-1800s or early 1900s, and only the gray wolf recently returned to the region in small numbers in Maine. Other forest species declined, including moose, black bear, beaver, wild turkey and pileated woodpecker. Heath hen, passenger pigeon, great auk, Labrador duck, and sea mink became extinct at the hand of humans during the same period (DeGraaf and Yamasaki 2001; Foster et al. 2002). In contrast, grassland species such as meadowlark, bobolink, upland sandpiper, and woodchuck increased as hayfields and pastures expanded during the early 19th century (Foss 1992; Foster and Motzkin 2003).

After farm abandonment escalated in the early 1900s, grassland species ebbed, while species of thickets, brush lands, and young forests surged (Litvaitis 2003). Populations of black bear, bobcat, and broad-winged hawks increased. At the same time, intense logging followed by intense fires and heavy rains continued to wreck havoc on forest habitat and associated wildlife species in northern New England (Foss 1992; DeGraaf and Yamasaki, 2001). The young hardwood forests that emerged in the 1920s and 1930s, after the old-field pine harvests, provided premier habitat for ruffed grouse and American woodcock (DeGraaf and Yamasaki 2001). Continued forest maturation caused those early successional species to decline to levels approaching pre-settlement levels (Litvaitis 2003).

Moose are common on the refuge

J. & K. Hollingsworth/USFWS

Nearly all the forest species that were extirpated or decimated have re-colonized the region. Some species arrived for the first time more recently. Eastern coyotes were first sighted in northern Maine in the 1930s, in Vermont and New Hampshire in the 1940s, and in Massachusetts in the 1950s (DeGraaf and Yamasaki 2001). DeGraaf and Yamasaki (2001) reported three major trends in New England's wildlife: forest species are increasing (e.g., bear, beaver, deer, wild turkey, pileated woodpecker), grassland and shrubland species are declining (e.g., bobolink, upland sandpiper, whip-poor-will), and many southern species are expanding their ranges northward (e.g., Carolina wren, northern cardinal, mockingbird, Virginia opossum). A few species, such as raven, fisher, and moose are expanding southward. A group of species remains regionally extirpated, including wolverine and mountain lion, although lynx have returned to northern Maine and New Hampshire (DeGraaf and Yamasaki 2001).

Current Conditions

Climate

The climate of the Upper Androscoggin River watershed is temperate continental, with warm summers, cold winters, and a relatively even distribution of precipitation throughout the year. The region has four distinct seasons. Winter temperatures, December through February, average only 14° F, with minimum temperatures as low as -34°F. The summer months, June through August, average 62°F, reaching highs of 96°F or more. In Errol, the town closest to the refuge headquarters at Wentworth Location, summers average about 60°–70°F. Precipitation in the watershed varies from 33 inches to more than 80 inches per year; most towns in the watershed receive 40 inches to 45 inches

per year. The average precipitation in Errol is 36 inches per year (Publicover and Weihrauch 2003).

Generally, Umbagog Lake freezes in December or January, and "ice-out' typically occurs in May. Ice on the lake can reach depths of 18–24 inches or more. Areas near river inputs and outputs can remain open throughout the year. The rivers associated with Umbagog Lake also freeze intermittently in the winter.

Hydrology
The Upper Androscoggin River watershed is part of the larger Gulf of Maine watershed: the latter being the geographic area from which all water drains into the Gulf. It is an immense area, extending from eastern Quebec to Cape Cod, Massachusetts, with a land base of 69,115 square miles and a water surface of 33,054 square miles. Maine is the only state located entirely within its boundary.

The waters of the Androscoggin River begin their journey in Maine along the anadian border. Rainfall and snowmelt gathers in small streams that eventually join to form the northern tributaries to the Androscoggin River: the Swift and Dead Diamond, Magalloway, Cupsuptic, and Kennebago. Those rivers flow into these lakes of the Rangeley Lake chain: Rangeley, Mooselookmeguntic, Cupsuptic, Upper and Lower Richardson, Aziscohos and Umbagog lakes. The Androscoggin River begins at Umbagog Lake and flows south, then turns east back toward Maine. Many other tributaries flow into the Androscoggin River as it continues its journey through Maine before finally meeting the Kennebec River in Merrymeeting Bay and emptying into the Gulf of Maine (Publicover and Weihrauch 2003).

Water Quality
Historically, the Androscoggin River experienced a period of degradation followed by recovery. Even as late as 1970, the river was considered one of the most polluted in the United States. Untreated effluent discharged into the river from the large paper mill was sufficiently noxious before the middle of the 20th century to produce fumes "rumored to peel the paint off houses." Low dissolved oxygen in the river made it unsuitable for most aquatic life, while foam and dark colors made it unappealing. The river made a remarkable recovery after the passage of the Clean Water Act in 1972, which forced the cleanup of point source pollution sources, including wastewater treatment plants and paper mills (Publicover and Weihrauch 2003).

Under the Clean Air Act, the Environmental Protection Agency (EPA) sets standards on a set of "criteria pollutants": carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), and lead (Pb) (EPA 1993). Those standards are referred to as the National Ambient Air Quality Standards (NAAQS). Areas that do not meet the standard for a particular pollutant are considered "non-attainment areas." The states of Maine and New Hampshire also have standards on other toxic pollutants. The only non-attainment areas in Maine and New Hampshire are in their southern portions, around more urban areas for ozone and in New Hampshire for small particles ($PM_{2.5}$). Coos County in New Hampshire and Oxford County in Maine meet the standards for all six criteria pollutants (US EPA 2005).

Evers (2005) documents a growing concern over mercury emissions and accumulation in aquatic and terrestrial systems in the Northeast. Mercury is emitted into the air as a byproduct from coal-burning power plants, incinerators, and other industrial plants. Once emitted into the air, mercury can travel for days before deposition through dry gases and particles, rain, or snow. The impact of mercury on humans and the environment depends on whether it converts into the toxic form of methylmercury. That form, if consumed, bioaccumulates as it

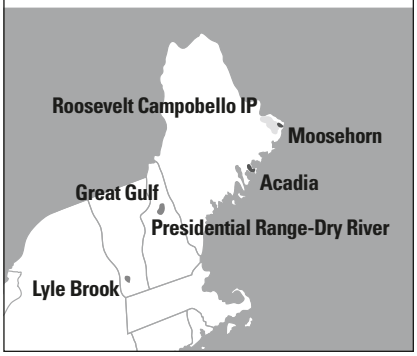
moves up the food chain, causing various reproductive and neurological problems for fish and wildlife. New models indicate that the greatest amount of mercury is deposited in forested and mountainous terrain, and scientists detected mercury accumulation in birds of mountain areas (e.g., Bicknell's thrush) as well as at lower elevations (e.g., northern waterthrush). Evers (2005) reports a suite of "biological hotspots," where mercury concentrations are elevated in fish and wildlife, which included the Rangeley Lakes region. All surface waters in New Hampshire and Maine are impaired for fish and shellfish consumption due to elevated levels of mercury in tissue (NHDES 2004; MDEP 2004).

Several water bodies in the Upper Androscoggin River watershed are listed as impaired waters that do not meet one or more of their uses, with the added condition that they require a total maximum daily load study. This study is designed to identify and reduce pollutants that are present in a lake or stream in order to attain an acceptable water quality standard. The Upper and Lower Richardson Lakes, parts of the Azicoshos Lake, Signal Pond, and the Androscoggin and Diamond rivers are in this category (NRCM 2005).

Air Quality

EPA regulates six criteria pollutants under the Clean Air Act of 1990 (CAA): ozone, carbon monoxide, nitrogen dioxide, particulate matter, sulfur dioxide and lead as well as hazardous and other toxic air pollutants, including mercury, under the CAA Amendments of 1990. States, tribal governments, and some local governments manage air quality in their administrative jurisdictions. The New Hampshire Department of Environmental Services (NHDES), Air Resources Division and the Main Department of Environmental Protection (Maine DEP), Bureau of Air Quality regulate criteria pollutants emitted in or transported into their respective States.

The CAA Amendments of 1977 established a program for the prevention of significant deterioration of air quality. Certain wildernesses and National Parks established before August 1977 were designated by the CAA as mandatory Class I areas. A Class I designation allows small increments of additional air pollution above baseline levels within the area so long as the national ambient air quality standards are complied with and the Air Quality Related Values (AQRVs) of the Class I area are not adversely affected. (USFS, 1991) Class I areas in the New England states are shown here:



For each criteria pollutant, EPA has established a maximum concentration above which adverse effects on human health may occur. These threshold concentrations are called National Ambient Air Quality Standards (NAAQS). Areas of the country where air pollution levels persistently exceed the NAAQS may be designated "nonattainment." When an area does not meet the air quality standard for one of the criteria pollutants, it may be subject to the formal rule-making process to designate it as nonattainment. The Clean Air Act further classifies ozone, carbon monoxide, and some particulate matter nonattainment areas based on the magnitude of an area's problem. Nonattainment classifications may be used to specify what air pollution reduction measures an area must adopt, and when the area must reach attainment (40 CFR 81).

September 2005 data indicate that southern NH and coastal ME are nonattainment areas for ozone but the refuge counties of COOS County, NH and Oxford County, ME are in attainment for all criteria pollutants. Of recent

concern, however, in the refuge area are ground-level ozone and fine particulate matter (PM2.5). Both are respiratory irritants (text box) that can cause serious health effects in susceptible individuals; though ozone is a concern in the Umbagog area only during the warmer months (text box).

Air quality monitoring records for Coos County, NH and Oxford County, ME (EPA 2005) indicate that ozone and PM2.5 have recently exceeded levels considered safe for sensitive subgroups. Air quality index measures show that in 2004, O3 exceeded sage levels on 3 days and PM2.5 exceeded safe levels on 2 days in Coos County. Oxford County had a single day in 2004 with unhealthy PM2.5 leves. Monitoring in 2005 through September indicates O3 and PM2.5 levels in the moderate range just below unhealthy levels.

A related concern in the region is the effect of air pollutants on visibility. Visibility is affected by ozone and by fine particulate matter (PM2.5) which manifests as regional haze in rural areas and is of particular concern in the Class I areas of designated wildernesses (text box), including the nearby Great Gulf Wilderness and Presidential Range –Dry River Wilderness, located about 50 miles south of Umbagog NWR in the White Mountains NF. (USFS 1991)

Ozone (O_3) (ground-level) – A colorless gas formed in chemical reactions between oxygen, volatile organic compounds (VOCs), and oxides of nitrogen (NO_x) is the major constituent of photochemical smog. Sources include vehicles, factories, landfills, industrial solvents, gas stations, lawn equipment. Irritates the respiratory tract; impairs lung functions such as ability to take a deep breath; causes throat irritation, chest pain, cough, lung inflammation, and possibly susceptibility to lung infection; aggravates existing respiratory conditions like asthma in certain individuals; may reduce yield of agricultural crops and injure forest and other vegetation. Ground-level ozone, more commonly called summertime smog, is measured in parts per billion (ppb). The federal health based standard for an 8-hour concentration is set at 80 ppb so levels above this standard are considered to be unhealthy. Ozone is a summertime pollutant so wintertime monitoring is limited and no wintertime forecast is provided. Full monitoring, reporting, and forecasting for ozone occurs from April through September.

Particulate Matter (PM) – Solid matter or liquid droplets from smoke, dust, fly ash, and condensing vapors from burning of wood, diesel and other fuels; industrial plants; agriculture (plowing, burning off fields); unpaved roads and construction. Causes nose and throat irritation, lung damage, bronchitis, and possibly prematu re death. Children, the elderly, and people suffering from heart or lung disease are especially at risk. Also damages paint, soils clothing and furniture, and reduces visibility. Particulate pollution (small particles) consists of both solid and liquid particles that are less than 2.5 microns in diameter (a micron is a millionth of a meter). Particle concentrations are measured in micrograms per cubic meter (ug/m^3) and levels above 40 ug/m^3 over 24 hours are considered to be unhealthy. Monitoring and reporting of small particles occur year-round.

(Source: NH DES 2005)

On a global scale, carbon emissions and other greenhouse gases (GHG) are recognized as contributing to global warming. Carbon sequestration, creation of complex organic matter through photosynthesis, locks up carbon organically in forest and other biomass "sinks" such as peat soils. The potential for managing carbon levels through forestry is significant. The Intergovernmental Panel on Climate Change's (IPCC) Second Assessment Report found that during the period 1995–2050, slowing deforestation, promoting natural forest regeneration, and encouraging global reforestation could offset 220–320 billion tons of CO2 (12–15%) of fossil emissions. Carbon sequestration may be accomplished through forest preservation to reduce deforestation; forest management techniques to enhance existing carbon sinks; creating new carbon sinks by planting on pasture, agricultural land, or degraded forest sites; and storing carbon in wood products (Dayal 2000). In the refuge area, acquiring forested lands that might otherwise be developed would allow preservation of forest cover, managing refuge forest lands for older-age stands would lock up more carbon for a longer time, and using tree plantings to restore old logging roads and camps would create additional forested land.

The ability of forests to serve as carbon sinks is related in turn to air quality. The forests of the New England region currently store 20 million metric tons of carbon per year, but poor air quality adversely impacts potential photosynthetic capacity, especially in sensitive species. Exposure of white pine to ozone in excess of 60-80 ppb, will result in a 15-20% reduction in annual wood production. If air quality can be improved for the region, wood production (carbon sequestration) would increase. Reducing CO2 and NOx emissions by improving gas mileage and reducing automobile traffic would effectively reduce ground-level ozone, and thus improve the carbon sequestration capabilities of regional forests (NERA 2002).

Conserved Lands Network

About 25 percent of the Upper Androscoggin River watershed is under some form of permanent conservation (map 1-1). This includes more than 200,000 acres owned in fee simple by federal and state agencies or conservation groups, and about 165,000 acres covered by conservation easements (Publicover and Weihrauch 2003). In addition to the refuge, the primary conservation lands in the Upper Androscoggin River watershed include the White Mountains National Forest, Appalachian Trail, Connecticut Lakes Headwaters, Pond of Safety, Connecticut Lakes Headwaters, Maine Bureau of Parks and Lands, Rangeley Lakes Heritage Trust lands, and Pingree Forest Partnership easements.

Regional and Local Economic Setting

We have taken the following information from a U.S. Geological Service, Fort Collins Science Center report (Koontz et al. 2006), which we funded as part of this CCP/EIS. Appendix G holds the entire report.

Regional and local demographics

The refuge is located in Coos County, New Hampshire, and Oxford County, Maine. Table 3.1 shows the population estimates and trends for the regional area and communities near the refuge. Although Coos is the largest New Hampshire county in total land area, it is the smallest in population, accounting for less than 3 percent of New Hampshire's total population in 2000 (U.S. Census Bureau 2000). From 1990 to 2000, New Hampshire's overall population increased by 11.4 percent, while Coos was the only county to lose population, decreasing by 4.9 percent over the same period. According to High et al. (2004), Coos County has not been able to benefit from population growth that accompanies economic development or interstate access to the same extent as counties in south and central New Hampshire.

In 2000, Oxford County accounted for approximately 4 percent of Maine's total population (U.S. Census Bureau 2000). From 1990 to 2000, the population growth rate for Oxford County was approximately 4 percent, which was similar to Maine's overall population increase (table 3.1).

The towns of Upton and Bethel in Oxford County and the towns of Errol, Berlin, Gorham, and Colebrook in Coos County are the primary communities near the refuge. Errol and Upton are closest to the refuge, and are the smallest communities in the area near it. The town of Errol is close to the western side of the refuge, and is the town nearest the refuge headquarters. In 2000, the population of Errol was 298 residents, averaging 4.9 persons per square mile. Upton is a very small community near the southern end of the refuge, with a population of 62 residents averaging 1.6 persons per square mile. Berlin is the northernmost city in New Hampshire, and is located approximately 30 miles south of the refuge near the White Mountain National Forest. The town of Gorham is located just south of Berlin. Colebrook is approximately 25 miles northeast of the refuge in northern Coos County, at the junction of the Connecticut and Mohawk rivers. Bethel is located approximately 35 miles southeast of the refuge on the Androscoggin River.

Table 3.1. Local and regional population estimates and characteristics

	Population in 2000			% Population Change	Projected % Population Change
	Residents	Persons per Square Mile	Median Age	1990 to 2000	2000 to 2010
New Hampshire	1,235,786	137.8	37.1	+11.4	+12.7
Coos County, NH	33,111	18.4	41.5	-4.9	-6.0
NH Communities near refuge					
Berlin	10,331	167.4	42.5	-13.0	-7.0
Colebrook	2,321	56.6	41.2	-5.3	-6.4
Errol	298	4.9	47.2	+2.1	-7.1
Gorham	2,895	90.7	42.0	-9.5	-6.7
Maine	1,274,923	41.3	38.6	+3.8	+4.6
Oxford County, ME	54,755	26.3	40.2	+4.1	+3.5
ME Communities near refuge					
Bethel	2,411	37.2	40.8	+3.2	+2.6
Upton	62	1.6	56.0	-13.9	+16.1

Source: U.S. Census Bureau (2005), Maine State Planning Office (projections compiled Dec. 2001 based on past trends), and New Hampshire Office of Energy and Planning (projections compiled Sept. 2004 based on past trends).

Economic Sectors, Including Timber and Tourism

According to the U.S. Department of Commerce, most jobs in Coos and Oxford counties were in the industries of manufacturing, health care and social assistance services, retail trade and government agencies. Compared to counties in southern New Hampshire and Maine, Coos and Oxford Counties have slower economic growth and a greater dependence on traditional natural resource based manufacturing activities (High et al. 2004). According to the New Hampshire Economic and Labor Market Information Bureau (2003), Coos County employment projections for 2000 to 2010 suggest most new jobs will be in service-related industries, especially in the fields of health services, amusement and recreation services, and business. Timber and tourism, the prominent natural-resource-based industries with ties to the refuge, are described in more detail below.

Timber Harvesting and Production Industries

Forests cover 95 percent (17.7 million acres) of Maine and 84 percent (4.7 million acres) of New Hampshire (NEFA 2004a, 2004b). Maine is the major timber producer of the larger North East State Foresters Association (NEFA) region (Maine, New Hampshire, Vermont, and New York), accounting for roughly half of wood produced annually (NEFA 2004a). In 2003, Maine harvested 5.9 million cords and processed almost as much (5.6 million cords) in-state (MDOC 2004). According to NEFA (2001a), imports to Maine in 2001 were dominated by pulpwood, and nearly 67 percent of its exports were high-value softwood sawlogs. In 2003, Oxford County accounted for 8 percent of the total amount of timber (sawlogs and pulpwood) harvested in Maine, ranking sixth in the state (MDOC 2004).

In contrast to the timber industry in Maine, New Hampshire is cutting much more timber than it is processing (High et al. 2004). In 2001, the amount of timber processed in New Hampshire accounted for approximately 83 percent of the

amount harvested within the state (NEFA 2001b). However, part of that difference could be due to the brief closing of the primary pulp mill near Berlin from October 2001 to June 2002. In 2002, Coos County accounted for 16.5 percent of the total timber harvested in New Hampshire, ranking second in the state to Cheshire County (USFS 2002).

In 2001, forest-based industries employed more than 21,600 people in Maine and 9,800 in New Hampshire, and generated more than $1 billion in income in Maine and $333 million in income in New Hampshire (NEFA 2004a, 2004b). According to NEFA, each 1,000 acres of forestland in New Hampshire supports 2.0 forest-based jobs, while 1,000 acres of forestland in Maine supports 1.2 forest-based jobs.

The New Hampshire Economic and Labor Market Information Bureau (2003) identifies the lumber and paper products industries as the mainstay of employment in Coos County. One integrated pulp and paper mill in the region is located between Berlin and Gorham. When the mills shut down between October 2001 and June 2002, they reopened under the ownership of Nexfor, Inc., of Toronto, Canada, and now employ about 500 union workers and 100 salaried workers (USFS 2005).

Pulp and paper industries accounted for the largest portion of regional forest related output (67 percent) and employment (44 percent), followed by the timber harvesting and logging industries, which account for approximately 15 percent of output and 24 percent of employment. Four thousand one hundred forty-eight jobs link directly to forest related industries, and account for 9.5 percent of the overall employment (43,570 jobs) in Coos and Oxford counties. This picture has changed in recent years.

In recent years, employment in the lumber and paper industries has declined (Maine State Planning Office 2005; New Hampshire Economic and Labor Market Information Bureau 2003). Coos County employment projections for 2000 to 2010 suggest the lumber and paper industries will continue to decline, possibly by a substantial amount, with workforce decreases of nearly 24 percent in paper industries and 39 percent in lumber industries (New Hampshire Economic and Labor Market Information Bureau 2005). Although employment and the number of mills in operation has decreased, the remaining mills maintain a production output for the region that is almost as large as it was four decades ago, due to improved machinery and greater yield from each log (NEFA 2004a, 2004b).

According to High et al. (2004), the increasing pressure from the global paper industry, increasing recycling of wastepaper, increasing efficiency in the pulping process, and the increasing loss of market share to other regions has contributed to the slower than expected growth in the regional pulpwood market. Trade agreements such as the North Atlantic Free Trade Agreement of 1994 also have affected trends in the regional timber market by creating opportunities for international trade, resulting in increases in exports from Maine and New Hampshire to Canada, while at the same time allowing new competitors into local markets (Innovative Natural Resource Solutions 2005; High et al. 2004).

Resource-based Recreation and Tourism

The travel and tourism industry continues to be a significant, growing contributor to the economies of Maine and New Hampshire. A survey of Maine visitors in 2003 estimated resident and nonresident visitors spent $6.1 billon in Maine, which directly and indirectly (i.e., the multiplier effect as initial spending is recycled through the economy) generated: $13.4 billion in sales of goods and services; 173,181 jobs; $3.8 billion in income; and $549 million in state and local tax revenue (Longwoods International 2004). Results suggest overnight visitors come to tour the state (36 percent), enjoy Maine's superb outdoors (24 percent),

take a beach vacation (12 percent), and attend a special event (10 percent). In 2003, the Maine lakes and mountains region was the primary regional destination for 15 percent, and was visited by 19 percent of those traveling in Maine (Longwoods International 2004).

In New Hampshire, resident and nonresident visitors spent $3.7 billon in 2002 (an increase of 2.9 percent from 2000): accounting for the multiplier effect, that spending generated $9.8 billion in sales of goods and services; 88,427 jobs; and $419 million in state and local tax revenue (Goss 2003). A recent survey of New Hampshire visitors in 2003 and 2004 by the Institute for New Hampshire Studies reports that popular visitor activities include sightseeing, skiing or snowmobiling, shopping, and scenic drives (Thurston 2004). The White Mountain region of New Hampshire was reportedly the most visited region in all seasons, followed by the lakes region (except in winter). Although the White Mountain region includes the southern section of Coos County and extends into Oxford County, the area around the refuge is known as the Great North Woods region. Survey results reported New Hampshire's Great North Woods region was visited by 15 percent of the visitors to New Hampshire during the summer and fall, 10 percent of winter visitors, and 7 percent of spring visitors (Thurston 2004).

Located within the Northern Forest, Coos and Oxford counties provide abundant year-round recreational opportunities. For example, in Coos County, 271 recreation areas cover nearly 30 percent of the county's total acreage (New Hampshire Office of State Planning 2003). Coos County employment projections indicate the amusement and recreation services industry will contribute 260 new jobs between 2000 and 2010 (New Hampshire Economic and Labor Market Information Bureau 2003).

Popular activities on or near the refuge include hiking, camping, wildlife viewing, picnicking, snowmobiling, fishing, hunting, boating, canoeing, and cross-country skiing. The area is also a nationally recognized destination for fall foliage enthusiasts. Appendix G provides details about the economic contributions of wildlife viewing, fishing, hunting, boating, and other recreational activities in Maine and New Hampshire.

Land Values

With approximately 25 percent of the Upper Androscoggin River watershed under some form of conservation protection, some residents in northern New Hampshire have expressed their concern that those conservation ownerships are having an economic impact on land values. The protection of land from development has resulted in a high demand for private lands in the are a and a subsequent increase in property taxes. About 75 percent of the shorefront properties on Umbagog Lake are protected from development through state or federal ownership, or through the dedication of development rights to land conservation groups. The limited supply of property available for development means that land in the private sector is in high demand (Personal communication: Mark Danowski 2003; Peggy Gallus 2003; Brian Lessard 2003). The limited supply of property available for development has increased that demand for land, and has led to spin-off development around Akers Pond, northwest of Errol (Personal communication: Mark Danowski 2003; Peggy Gallus 2003; Brian Lessard 2003). Although that new property development has increased local property tax collections, thus helping offset the loss in taxes from state and federal government ownership, it has also raised concerns about habitat fragmentation and the loss of traditional recreational access with future development.

The Refuge and its Resources

Refuge Administration

Establishment

The original proposal to establish the refuge represented a partnership of protective efforts, involving the participation of the states of New Hampshire

Bill Hanson FPLE Maine Hydro/USFWS

Bald eagle chicks in nest

and Maine, timber companies, conservation organizations, private landowners, and the Service to cooperatively protect important lands surrounding Umbagog Lake. The larger effort was conceived to preserve existing land uses, including wildlife habitat, timber management, and traditional public uses on lands in the vicinity of the lake. The proposal was initiated in response to several events that were occurring in the region.

In the 1980s, the long standing tradition of timber companies owning the mills and the land shifted, and lands once thought to be held in perpetuity by the large timber companies started to come on the market. Nash Stream State Forest was created in 1988 when Diamond International put 90,000 acres up for sale in northern New Hampshire and Vermont, part of 1.5 million acres of forestland across northern New England and New York split off from the mills by an investor, and resold in smaller parcels for development. At the same time, despite a national economic slowdown, New England was experiencing an unprecedented building boom. Local residents and conservation groups were nervous about the possibility that James River would sell its high value shoreline property to developers and second-home buyers. Residents and environmentalists had stopped earlier threats to the lake, including plans to mine its shallow bottom, build a floating restaurant, and add a hydro dam with high-tension lines (Dobbs and Ober 1995).

In 1988, a pair of bald eagles started building a nest atop a tall white pine on the edge of Umbagog Lake in Leonard Pond. The following spring, they returned to that nest, built in the same tree that eagles had last nested in 40 years before. The desire of the James River Corporation to ensure the long term protection of the unique characteristics of the Umbagog lake area, and the establishment of a second pair of eagles in 1990, provided significant impetus for creating the refuge. Initially, many local residents strongly opposed federal ownership of the lands around Umbagog Lake. Through many meetings with small groups, the Service garnered the support of many who initially opposed the concept (Dobbs and Ober 1995).

As we mentioned in chapter 1, Congress authorized the establishment of the refuge for the purposes of conserving the unique diversity of wetlands habitats and associated wildlife and protecting water quality in the area. The Service has acquired 21,650 acres as of January 2008. An additional 7,482 acres are approved for acquisition from willing sellers.

Staffing and Budgets

The annual budget appropriation from 1997-2005, shown in table 3.2, has very little available discretionary funding. Operating budgets have increased as staffing levels have increased, and reflect annual funding for special projects, moving costs for new employees, and equipment purchases. Maintenance budgets remained relatively stable over the last 5 years.

Refuge operations and maintenance spending contribute directly to the local economy.

Table 3.2. Refuge staffing and budgets, 1998–2005

	Operations (Including Salaries)	Maintenance	Total	Full-Time[1] Staff	Seasonal Staff
1998	$138,900	$26,300	$165,200	3	0
1999	$232,500	$0	$232,500	3	1
2000	$273,440	$31,000	$304,440	4	1
2001	$264,620	$33,000	$297,620	4	1

	Operations (Including Salaries)	Maintenance	Total	Full-Time[1] Staff	Seasonal Staff
2002	$450,890[2]	$34,400	$485,290	6	0
2003	$423,162	$390,553[3]	$813,715	6	1
2004	$416,620	$169,341[3]	$585,961	5	0
2005	$410,926	$163,906[3]	$574,832	5	1
2006	$430,630	$259,271[3]	$689,901	5.5	0
2007	**$395,970**	**$99,600**	**$495,570**	**4.5**	**0**

Notes
[1] *Appendix H depicts staffing positions currently filled and vacant.*
[2] *Includes two new staff positions and special funding to conduct wildlife surveys*
[3] *Includes facility construction, building removal, and equipment replacement*

Our staff has tracked refuge purchases in the local community for fiscal years 1999 through 2005, shown in table 3.3.

Table 3.3. Local purchases by Lake Umbagog refuge staff FY 1999–2005

	Errol/ Wentworth Location, NH/ Wilson's Mills, ME	Berlin/ Gorham/ Milan/ Dummer, NH	Colebrook, NH	Bethel/ Mexico/ Rumford, ME	Oquossoc/ Rangeley, ME	Annual TOTALS
1999						
# Vendors	10	18	2	5	2	37
Total expenditure	$29,401	$17,695	$295	$2,623	$8,704	$58,719
2000						
# Vendors	6	26	1	4	1	38
Total expenditure	$77,320	$7,696	$2,000	$4,729	$4,209	$95,954
2001						
# Vendors	6	26	1	4	1	38
Total expenditure	$73,927	$13,442	$9,973	$12,030	$131	$109,503
2002						
# Vendors	9	27	6	2	1	45
Total expenditure	$67,361	$16,995	$5,257	$347	$294	$90,255
2003						
# Vendors	10	27	9	7	1	54
Total expenditure	$27,201	$16,140	$7,416	$21,282	$78	$72,116
2004						
# Vendors	14	26	6	2	1	49
Total expenditure	$53,270	$12,002	$3,638	$468	$85	$69,481
2005						
# Vendors	20	21	8	4	0	53
Total expenditure	$52,073	$6,064	$5,990	$2,161	$0	$66,288

Refuge Revenue Sharing Payments
Land in the refuge is not on the local tax rolls. The Refuge Revenue Sharing Act (16 U.S.C. §715s) offsets the loss of local tax revenues from federal land ownership through payments to local taxing authorities. In both Maine and New Hampshire, those payments go to the townships. The annual payments are calculated on the appraised value for tax purposes, and are reduced proportionally based on the amount appropriated by Congress. For fiscal year (FY) 2005, payments represent 44 percent of the fully funded revenue sharing formula. Our sources of payment funds are revenues or income generated within the Refuge System from such programs as mineral and facility leases, timber harvest and grazing permits. As shown in table 3.4, the Service made the following refuge revenue sharing payments to local townships in recent years.

Table 3.4. Refuge revenue sharing payments to towns, 2001-2007

Township	2001	2002	2003	2004	2005	2006	2007
Magalloway, ME	$5,543	$5,657	$5,285	$5,709	$5,049	$5,702	$5,278
Upton, ME	$5,911	$6,828	$7,079	$6,804	$6,018	$10,376	$10,936
Cambridge, NH	$744	$759	$709	$681	$603	$681	$630
Errol, NH	$11,517	$11,755	$22, 948	$22,056	$19,509	$25,973	$24,039
Wentworth Location, NH	$3,112	$4,959	$6,057	$6,119	$6,467	$7,304	$7,041

Refuge Headquarters and other refuge buildings
The refuge headquarters is located in Wentworth Location on New Hampshire State Route 16, approximately five and a half miles north of the Town of Errol, New Hampshire. The office complex includes an office building, cabin, parking lot, and boat launch on the east side of Route 16, and a parking lot and storage shed on its west side. The office is on the bank of the Magalloway River, a major tributary to Umbagog Lake.

The office building was built in 1996 as the administrative headquarters, including staff offices, a lobby or reception area for visitors, literature and displays, a small meeting room, and public rest facilities. In addition to refuge staff, the office also hosts a Regional Refuge Field Biologist whose duties cover activities throughout the Northeast Region. The office working space is inadequate and cramped for existing staff. The visitor contact area in the front office is also very small with limited room for interpretation and information displays. A small cabin next to the office serves as overflow office space (particularly for seasonal interns), and houses a GIS lab, a biology lab, and storage. Parking for six visitor cars is next to the office building, but staff parking is across Route 16. The refuge places floating docks in the Magalloway River behind the office during ice-free months to moor refuge boats. A public docking area provides lake access for canoes, kayaks, and other boats. A picnic table and small parking area make this a popular stopping place for visitors.

Due to the configuration of the office site, which is on a parcel approximately 80 ft wide, the current office location does not comply with local and state setbacks from the river. The site also provides no room for expansion to alleviate that concern or mitigate its other shortcomings. For example, if the footprint of the building were expanded, parking adjacent to the building would be reduced, forcing most visitors to park across Route 16. That parking area is already a safety concern, as log truck traffic can be quite heavy on this road, which offers poor sight distance.

A maintenance shop that stores all of the refuge's large equipment was built in 2005 at the south end of the lake, off Mountain Pond Road. In addition to the refuge headquarters complex and maintenance building, other refuge facilities include the "Potter Farm" and three houses used as quarters for interns, volunteers, and researchers. The Potter Farm is located on the west central shore of the lake on Potter Cove, and includes a large, deteriorating farmhouse overlooking Umbagog Lake and a large barn. Both the house and barn have been determined unsafe for occupancy in their current condition. The fields associated with this property are used for events such as "Take Me Fishing." The three houses used as quarters are located north of the refuge office on Route 16 in Wentworth Location, New Hampshire, and Magalloway Plantation, Maine. We plan to remove some secondary outbuildings associated with those houses.

Research

Refuge staff, graduate students, conservation organizations, and others have conducted numerous surveys and studies on the refuge. A sampling of those efforts follows. Additional information on these studies can be obtained from refuge headquarters.

Regional amphibian monitoring: Regional study from 1999-2002 to gather baseline data on presence of breeding amphibians. Anuran call counts were conducted at four locations on the refuge: Leonard Marsh, Harper's Meadow/ Sweat Meadow, Dead Cambridge River, Magalloway River.

National marshbird monitoring: Regional study from 1999-2005 to gather baseline data on breeding marsh birds. Call playback point counts were conducted at 3 locations on the refuge: Leonard Marsh, Harper's Meadow/ Sweat Meadow, Dead Cambridge River.

Loon, bald eagle, and osprey breeding surveys: Annual surveys and reports prepared by various contractors for the refuge.

A study of the vegetation and floristic diversity of two peatland complexes of post-settlement origin in Lake Umbagog National Wildlife Refuge, Coos County, New Hampshire: Conducted by Maire Nazaire in 2005. Master's Thesis, University of Vermont, Burlington, Vermont (Nazaire 2005)

Macro-invertebrate assessment report: Umbagog National Wildlife Refuge. Conducted by Rick Van de Poll in 2004. Ecosystem Management Consultants, Sandwich, New Hampshire (Van de Poll 2004)

Ecological Communities of the Lake Umbagog National Wildlife Refuge: Classification and Mapping with the National Vegetation Classification System. Conducted by Josh Rapp 2003. University of Vermont, Burlington, Vermont. (Rapp 2003)

Inventory of wetland communities around Umbagog Lake. Conducted by D.D. Sperduto in 1999. New Hampshire Natural Heritage Inventory, Concord, New Hampshire. (Sperduto 1999)

Water quality surveys on the refuge between 1979-1995 by New Hampshire Department of Environmental Services, the U.S. Environmental Protection Agency, and the U.S. Fish and Wildlife Services, Ecological Services

Contaminant surveys, primarily focused on mercury in fish and fish-eating birds since the early 1990s. Conducted by the by Biodiversity Research Institute, Maine and the U.S. Fish and Wildlife Service, Ecological Services (BRI 1997)

Special Use Permits
The refuge manager issues special use permits on a case-by-case basis after determining whether the use is compatible with refuge purposes. All special use permits have a one-year term. Since 2000, we have issued annual special use permits for such activities as surveying and monitoring wildlife, trimming brush; installing a fire hydrant; accessing private lands on Big Island; and, allowing hunters with disabilities to use ATVs for hunting big game.

Camps
We also issued special use permits for 25 cabins leased on the refuge. Most of the current cabin sites were acquired in an agreement when the original refuge lands were purchased from James River and Boise Cascade companies. With the purchase of lands from the Mead Paper Company in 2000, we agreed to an additional five leases. Most of the leases are located in Thurston Cove; five are in the Chapel Hill Road development; one is in Upton; and one is on Big Island.

Those privately owned cabins are on leased lands owned by the refuge and governed by special use permits. Those leases expire at the end of a 50-year period from when the refuge purchased the lands and include certain conditions, such as (1) the camps must be maintained in a manner compatible with the purposes of the refuge and produce the least amount of environmental disturbance; and, (2) no new permits will be issued for the construction of new camps on the properties. About a third of the lease owners are local residents from the Errol, Berlin, Gorham, and Milan area; a third are from other towns and cities in New Hampshire; and a third are from other states, including Maine, Georgia, and Texas. Approximately 10 leases have changed ownership at least once or twice since the refuge was established in 1992. The remaining camp lots have continued to be leased by the same individual(s) since 1992. Table 3.5 below identifies the annual revenues generated by issuing these camp lot leases. The proceeds from the camp lot leases go into the Refuge Revenue Sharing Account.

Table 3.5. Camp lot lease information and revenues generated, 1996–2007

Year	No. of leases	Range of fees charged	Total lease revenue for year
1996	24	$50-$1,881	$27,461
1997	24	$50-$1,515	$27,032
1998	24	$50-$1,515	$27,077
1999	23	$70-$1,650	$29,289
2000	26	$1-$1,650	$31,603
2001	29	$1-$1,650	$39,944
2002	25	$1-$1,650	$32,524
2003	24	$1-$1,650	$32,530
2004	26	$1-$1,650	$31,160
2005	25	$1-$1,650	$30,248
2006	28	$1-1,650	$33,773
2007	27	$1-1,650	$33,703

Status of Step-Down Plans and Compatibility Determinations

As we mentioned in chapter 1, Refuge System planning policy identifies at least 25 potential step-down plans. Although not all on that list are relevant for this refuge, we completed a Hunt Plan in 2000 and a Continuity of Operations Plan in 1999. See Chapter 2, "Description of the Alternatives," for our schedule for completing additional step-down plans, including a HMP, IMP, FMP, and VS plans.

We have completed compatibility determinations for the special use permits mentioned above and for our hunting program. Appendix C includes new compatibility determinations for our current and proposed programs.

Refuge Natural Resources

Hydrology

Umbagog Lake is the centerpiece of the refuge, lying in a broad, flat basin along the Maine-New Hampshire border for a linear distance over 7 miles. The westernmost of the Rangeley Lakes chain, Umbagog Lake was only a thousand acres, until in 1851 a dam was built to power a sawmill. As the dam was enlarged and improved, it eventually flooded more than 7,000 additional acres of low-lying forest and floodplain. For more than 100 years, those saturated lands developed into peatlands, cedar swamps, floodplain forests, and lakeshore swamps (Dobbs and Ober 1995). Aerial photographs show a decrease in emergent vegetation in the Leonard Marsh and Harper's Meadow area since the early 1970s, a time when impounded water may have been maintained at lower levels.

Three significant rivers drain into Umbagog Lake. The Magalloway River enters the lake on the northwest side, draining a 300-square-mile area of nearly undeveloped yet actively harvested forest. The Magalloway starts at the Canadian border, flows through Parmachenee Lake, Aziscohos Lake, and Sturtevant Pond in Maine before entering New Hampshire and draining south into Umbagog Lake. From the west, the Swift and Dead Diamond rivers are major tributaries to the Magalloway as it enters the Umbagog Lake backwaters. The Rapid River enters Umbagog Lake from the east, draining the entire 500-square-mile Rangeley lakes region of western Maine. The much smaller Dead Cambridge River flows into Umbagog Lake from the southeast. The Androscoggin River forms the outlet, leaving Umbagog Lake near the mouth of the Magalloway River.

Magalloway River

Ian Drew/USFWS

The refuge encompasses four small ponds on the New Hampshire side of the lake: Mountain Pond (19 acres), East Whaleback and West Whaleback ponds (8 acres and 9 acres, respectively), and Brown Owl Pond (27 acres). Other small tributaries also feed into Umbagog Lake.

Errol Dam
The Androscoggin River Improvement Company originally built Errol Dam in 1852. The dam controls water flows and levels in Umbagog Lake. Union Water Power Company (UWP) owned and operated the dam from 1878 and was the owner-operator at the time the refuge was established. UWP managed the water levels in Umbagog Lake, along with those in other Rangeley lakes, to maintain flow in the Androscoggin River and provide hydropower under a license issued by FERC. Article 27 of FERC license #3133–001 for Errol Dam requires UWP, in consultation with appropriate agencies, to conduct a study to identify the reservoir surface elevation and time of year at which stable water levels are needed for the protection of nesting wildlife on Umbagog Lake, and to develop a reservoir level management plan (FERC 1983).

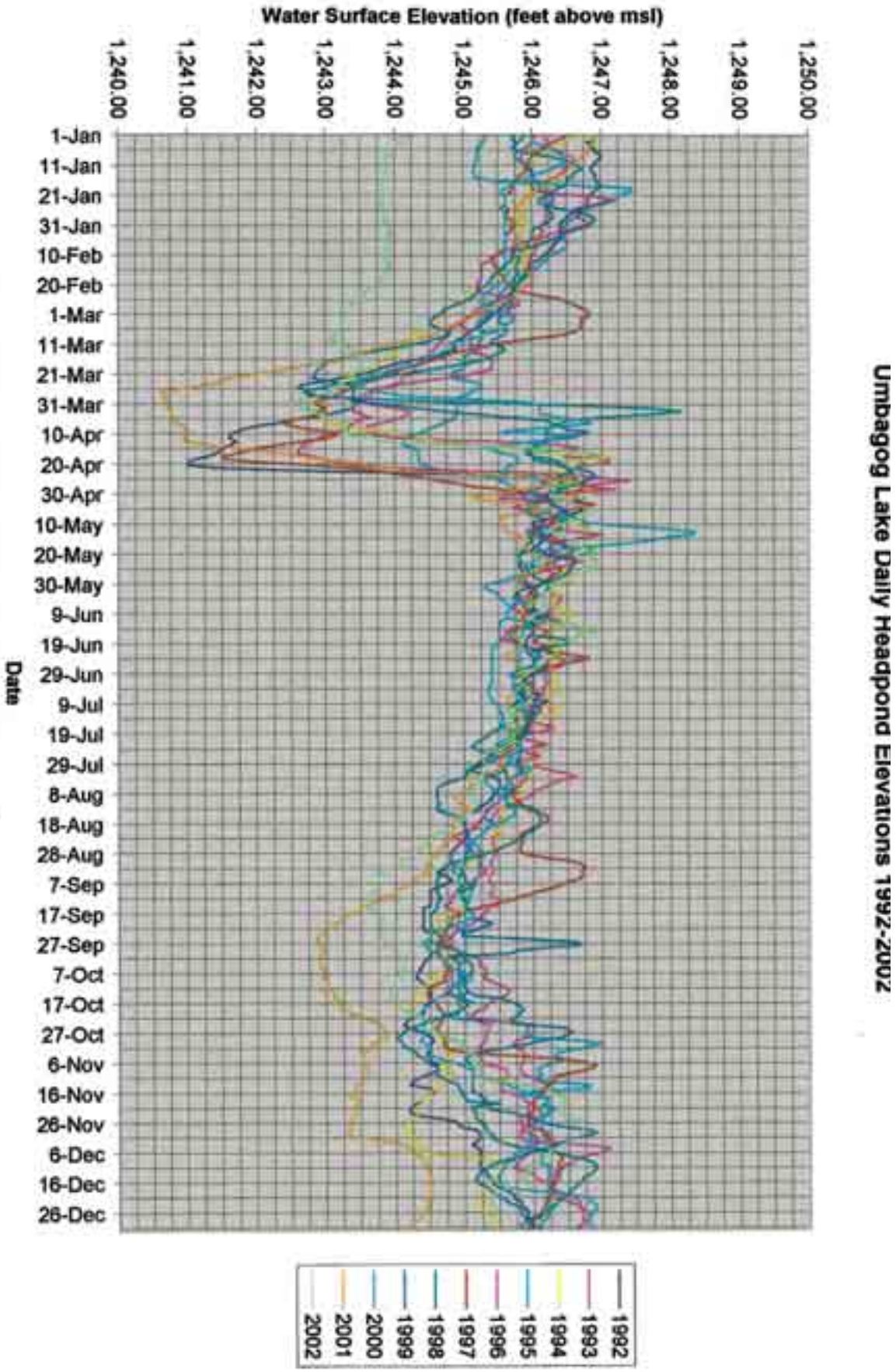
UWP developed a water level management plan in consultation with the Service, NHFG, MDIFW, and ASNH, represented by the LPC. One major objective of the plan was to "minimize impacts on fish and wildlife which result from the flow management of the Androscoggin River, while balancing commitments to downstream user, regulating flood flow protection, and maintaining the most expedient water level regime for enhancing fish and wildlife within the Umbagog Reservoir." The plan also provided for continuing review and input into water level management through annual meetings of the power company with the state agencies, Service, and LPC.

UWP agreed to maintain water levels based on a level set on June 1, and to restrict change to no more than a six-inch increase or a one-foot decrease. That agreement was amended in 1998 to specify that the water level be maintained at a 1,246-foot mean sea level (msl) elevation as of June 1, and held constant until 75 percent of loon nests were established (generally by June 20). A gradual six-inch drawdown then was initiated over a two-week period. That lower level was to be held constant for an additional month, until after 75 percent of the nests had hatched, or approximately July 20. After July 20, UWP could fluctuate lake levels (Fair 1998; Paul Dunlop, UWP, telephone communication 1998). FPLE manages under the same FERC license as UWP, which require them to limit water level fluctuations during the loon nesting season of June and July, based on the annual conservation partner meetings. The reservoir water level management plan is for the benefit of wildlife species and the water users downstream of the Errol Project.

Over the past 10 years, the river levels at the Errol Dam generally were maintained at 1,245.5 feet to 1,247.5 feet msl from the end of April through early March. Levels are drawn down to 1,243 feet or lower between early March and the end of April. A less pronounced drawdown occurs from mid-September through the end of October. In approximately 1 out of every 5 years, unusually low or high water level "spikes" occur, making it difficult for UWP to manage water levels within the current agreement. Figure 3.1 displays daily Umbagog Lake headpond elevations from 1992 to 2002.

Soils

The Natural Resource Conservation Service completed an updated soil survey on the refuge in 2004 (USDA 2004). Most of the soils that cover the hillsides and upland forests in the refuge area derive from glacial till. The soils formed in alluvium, glacial outwash, lacustrine sediments, or organic materials, though less extensive in area, are significant, as they support diverse habitat types surrounding the lakeshore. Table 3.6 presents the major soil types on the refuge.



Umbagog Lake Daily Headpond Elevations 1992-2002

Table 3.6. Soils mapped on the Lake Umbagog refuge (USDA 2004)

Soil Code	Soil Name, Slope	Origin	Drainage
14B	Sheepscott cobbly fine sandy loam	Glacio-fluvial/outwash	Moderately well drained
27B/C	Groveton fine sandy loam	Glacio-fluvial/outwash	Well drained
28A	Madawaska very fine sandy loam	Glacio-fluvial/outwash	Moderately well drained
36B/C	Adams loamy sand	Glacio-fluvial/outwash	Excessively drained
55C	Hermon sandy loam	Glacial till	Somewhat excessively drained
57D	Becket fine sandy loam	Glacial till	Well drained
59B/C	Waumbek sandy loam	Glacial till	Moderately well drained
61C/D/E	Tunbridge-Lyman-Rock outcrop complex	Glacial till	Well drained
73D	Berkshire very fine sandy loam	Glacial till	Well drained
77C/D/E	Marlow gravelly fine sandy loam	Glacial till	Well drained
79B/C/D	Peru fine sandy loam	Glacial till	Moderately well drained
143C/D/E	Monadnock fine sandy loam	Glacial till	Well drained
169B/C/D	Sunapee fine sandy loam Sunapee	Glacial till	Moderately well drained
214B	Naumburg fine sandy loam	Glacio-fluvial	Poorly drained
247A/B	Lyme fine sandy loam	Glacial till	Poorly drained
415B	Moosilauke loam	Glacial till	Poorly drained
470B	Tunbridge-Peru complex	Glacial till	Well drained
523E	Stetson fine sandy loam	Glacio-fluvial	Well drained
549A	Peacham muck	Glacial till	Very poorly drained
559A	Skerry fine sandy loam	Glacial till	Moderately well drained
560C	Tunbridge-Plaisted-Lyman complex	Glacial till	Well drained
567B/C/D	Howland silt loam	Glacial till	Moderately well drained
579B/C/D	Dixmont very fine sandy loam	Glacial till	Moderately well drained
590A/B/C	Cabot gravelly silt loam	Glacial till	Poorly drained
613B	Croghan loamy fine sand	Glacio-fluvial	Moderately well drained
632B	Nicholville very fine sandy loam	Glacio-lacustrine	Moderately well drained
633A	Pemi silt loam	Glacio-lacustrine	Poorly drained
647B/C	Pillsbury sandy loam	Glacial till	Poorly drained
670C	Tunbridge-Berkshire-Lyman complex	Glacial till	Well drained
670D	Tunbridge-Plaisted-Lyman complex	Glacial till	Well drained
995A	Wonsqueak muck	Organic materials	Very poorly drained
A=0%–3% slope; B=3%–8% slope; C=8%–15% slope; D=15%–25% slope; E=25%–30% slope			

The Mixed Forest Matrix and Habitat Types

We define the "forest matrix" as the most extensive, most connected, and most influential landscape type across the Upper Androscoggin River watershed basin. Knowing the matrix is important because it influences ecological processes that may affect biodiversity, including the amount and distribution of wildlife species. In the Upper Androscoggin River watershed, the forest matrix is not dominated by any one forest type, but is a mosaic of many types, and is often

referred to at the larger landscape scale as a mixed spruce-fir/northern hardwood forest (Kuchler 1964; Charlie Cogbill, personal communication 2004). As we further delineate the mixed forest matrix, at the refuge scale, we define three predominant forest types embedded in it: spruce-fir; conifer-hardwoods mixed woods; and, northern hardwoods. We refer to these three forest types in this document as "habitat types," along with eight other habitat types we propose management objectives for: fen and flooded meadow, boreal fen and bog, northern white cedar, scrub-shrub wetlands, wooded floodplain, and lakeshore pine-hemlock. Each of those habitat types is found in varying amounts on the refuge and in the surrounding landscape.

Table 3.7 summarizes our classification of those habitat types for the refuge. We derived them from several sources. Our primary source was a cooperative mapping project with the University of Vermont, Spatial Analysis Laboratory, using the NVCS (Rapp 2003). We supplemented those data with aerial photo flights and interpretation generated in 2004 by the James W. Sewall Company of Old Town, Maine. The acreages in the table are approximations based on digital boundary mapping and photo-interpretation using a GIS database.

We grouped several natural communities into broader habitat types shown in table 3.7. The habitat groupings provide a coarser, more practical scale for mapping and applying management actions in the field. Wildlife, our main management focus, typically responds to habitat conditions at that broader scale. In addition, many of the natural communities we have grouped under a single habitat type occur naturally together as an ecologically system, often with one community merging into another. Thus, they often function ecologically as one habitat.

The following habitat type descriptions correspond to the list in table 3.7 and to the depictions on map 3-1. In addition, appendix M presents a cross-walk table of NVCS association, and various other vegetation classification systems and their relationship to refuge habitat types.

Table 3.7. Habitat types and acres in the approved Lake Umbagog Refuge boundary

Habitat Type	NVCS Association (UVM 2003)	Acres owned by the refuge*	Acres not owned by the refuge	Totals
Wetlands				
Fen and Flooded Meadow	Medium fen-wet phase Medium fen Cattail marsh Seasonally flooded mixed graminoid meadow Eastern tussock sedge meadow Spikerush shallow emergent marsh Few-seeded sedge-leatherleaf fen	487	79	566
Boreal Fen and Bog	Leatherleaf poor fen Medium shrub fen Sub-boreal dwarf-shrub fen Circumneutral pattern fen Spruce-fir swamp Black spruce wooded bog Black spruce-larch swamp	1,235	167	1402
Northern White Cedar	Northern white-cedar- balsam fir peatland swamp Northern white-cedar-black ash swamp Northern white-cedar-boreal conifer mesic forest Northern white-cedar peatland swamp Northern white-cedar seepage forest Northern white-cedar wooded fen	829	202	1,031

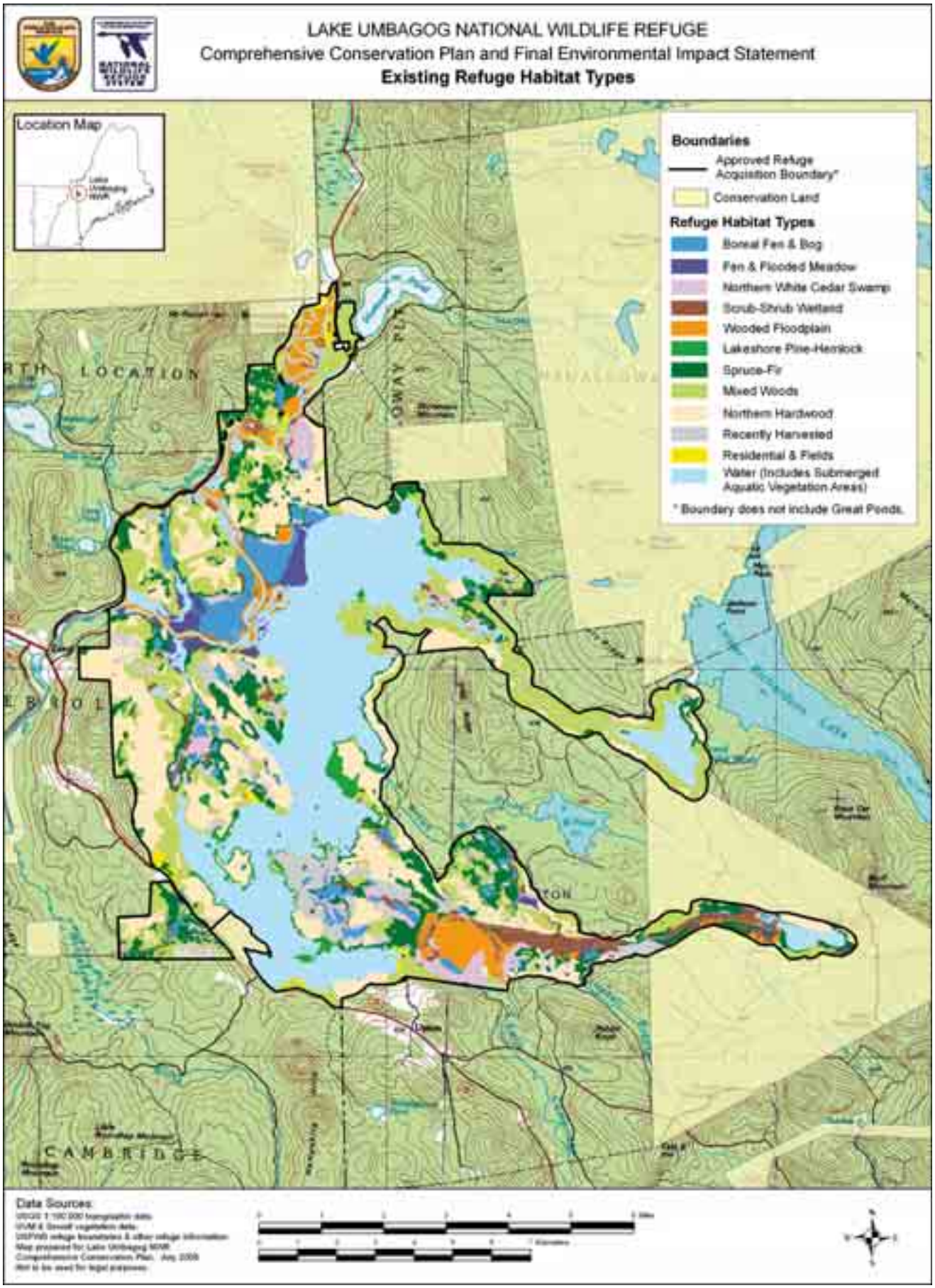
Habitat Type	NVCS Association (UVM 2003)	Acres owned by the refuge*	Acres not owned by the refuge	Totals
Wetlands (cont'd)				
Scrub-Shrub Wetlands	Speckled alder peatland lagg (Speckled, green) alder shrubland Speckled alder swamp Sweetgale mixed shrub thicket	682	258	940
Open Water and Submerged Aquatic Vegetation**	Water ***	5,033	801	5,834
Floodplain and Lakeshore				
Wooded Floodplain	Red maple floodplain forest Red maple-balsam fir floodplain forest White spruce-balsam fir berm woodland Red maple-tussock sedge floodplain woodland Black ash-mixed hardwoods swamp Red maple-black ash swamp	1,140	153	1,293
Lakeshore Pine-Hemlock	Hemlock mesic forest Hemlock-hardwoods forest Hemlock-white pine- red spruce forest Red pine-white pine forest Jack pine/blueberry/feathermoss forest	232	288	520
Uplands				
Spruce-fir	Lowland spruce-fir forest Red spruce rocky summit Black spruce - red spruce forest	2,346	956	3,302
Mixed Woods	Aspen-fir woodland Successional spruce-fir forest Red spruce- hardwoods forest	3,859	2,454	6,313
Northern Hardwoods	Early successional aspen-birch forest/woodland Red maple-yellow birch early successional woodland Northern hardwood forest Semi-rich northern hardwood forest Paper birch talus woodland	4,640	1,428	6,068
Other				
Recently Harvested	Recently disturbed	1,058	551	1,609
Fields and Residences	Residential	109	145	254
TOTAL		21,650	7,482	29,132

Table Notes

** These values primarily represent Service-owned refuge lands, fee ownership only. The only exception is a 6-acre Service easement in the Potter Farm area that is incorporated into the spruce-fir type. Data sources include a NVCS map created by University of Vermont, Spatial Analysis Laboratory in February 2003; supplemented with a timber stand map created by Sewell, Inc. in December 2003, and additional Service photo interpretation in 2005. The acres are approximations based on digital mapping in a GIS database.*

*** Water acreage does not include Great Ponds in either state, but does include acres under rivers and other small water bodies. Refuge ownership on Umbagog Lake includes all acquired shoreline extending to the original Great Ponds, which existed before the lake's impoundment.*

**** Floating-leaved and submerged aquatic vegetation communities have not been mapped, but likely include associations in the following NVCS Alliances: White Water-lily-Yellow Pond-lily species Permanently Flooded Temperate Herbaceous Alliance and Pondweed species-Coontail species-Waterweed species Permanently flooded Herbaceous Alliance.*


LAKE UMBAGOG NATIONAL WILDLIFE REFUGE
Comprehensive Conservation Plan and Final Environmental Impact Statement
Existing Refuge Habitat Types
Location Map
Boundaries
Approved Refuge Acquisition Boundary*
Conservation Land
Refuge Habitat Types
Boreal Fen & Bog
Fen & Flooded Meadow
Northern White Cedar Swamp
Scrub-Shrub Wetland
Wooded Floodplain
Lakeshore Pine-Hemlock
Spruce-Fir
Mixed Woods
Northern Hardwood
Recently Harvested
Residential & Fields
Water (Includes Submerged Aquatic Vegetation Areas)
* Boundary does not include Great Ponds.
LOCATION
CAMBRIDGE
Data Sources:

Wetlands, Floodplains, and Open Water and Submerged Aquatic Vegetation Habitats

Approximately 10 percent of the wetlands in the entire upper Androscoggin River watershed is on the refuge, and those are the most extensive and diverse in the upper watershed (Publicover and Weihrauch 2003). The wetlands, floodplain and lakeshore forest, and open water cover 47 percent (9,555 acres) of the refuge.

Peatlands

Peatlands are a wetland type whose soils are "peat"—partially decayed remains of dead plants. Peatlands are described by topography: flat or level, on slopes, or raised. They also are classified by their water and nutrient characteristics.

Minerotrophic peatlands receive water primarily from underground or surface sources; the water picks up nutrients as it passes through soil and bedrock. Ombrotrophic peatlands receive their water from precipitation. *Oligotrophic* peatlands are between the other two in nutrient richness.

A *fen* is a strongly enriched (primarily minerotrophic) peatland, while a *bog* is a rain-fed (largely ombrotrophic) peatland. The northeast supports a range of peatland types, with many different types often occurring together in large peatland complexes (Johnson, 1985).

Fen and Flooded Meadow

Fen and flooded meadow habitat covers<3 percent (482 acres) of refuge lands. This habitat type encompasses several plant communities defined by NVCS. Those include medium fen, cattail marsh, seasonally flooded mixed graminoid meadow, eastern tussock sedge meadow, spikerush shallow emergent marsh, and few-seeded sedge-leatherleaf fen (Rapp 2003). Fen and flooded meadow is found primarily in the backwaters of the Magalloway River, along the southern and eastern edges of Leonard Marsh, in Leonard Pond, Harper's Meadow, Sweat Meadow, and Chewonki Marsh, along the mouth of the Rapid River, and in the Mountain Pond and Dead Cambridge drainage.

These communities are found on seasonally or temporarily flooded to semi-permanently flooded areas with acidic soils. Depending on the specific community type, sedges, grasses, cattail, and sphagnum are the dominant herbaceous plants. Leatherleaf, sweet gale, and spireas are common shrubs in those communities. Although soil substrate and soil pH vary among these communities, all are located in stream floodplains, beaver meadows or along lake or pond shorelines. Snags are still visible in some areas of the fen and flooded meadow, an area of low-lying forest before the Errol Dam was built and raised the water levels (Little 1974).

Fen and flooded meadow is nesting and brood rearing habitat for American black duck, ring-necked duck, and mallard. Several marsh birds, including pied-billed grebe, sora, Virginia rail, American bittern, and Wilson's snipe, nest in these wetlands. Cavity-nesting wood duck, common goldeneye, common and hooded merganser also forage here with their broods. During fall migration, waterfowl—the nesters as well as migrant scaup, scoters, and snow geese—use the wetlands as secure foraging sites. When water levels are low during spring and fall migration, several shorebird species (e.g., greater yellowlegs, solitary sandpiper, killdeer) stop over at the refuge. Northern leopard frog and mink frog also occur in these wetland habitats.

Rare Plants in the Fen and Flooded Meadow

Meagre sedge is state-listed as threatened (S1) in New Hampshire. That rare plant was detected in the seasonally flooded graminoid meadow and in the circumneutral-patterned fen described below.

Boreal Fen and Bog

Boreal fens and bogs cover 6 percent (1,184 acres) of the refuge, and include the NVCS communities leatherleaf poor fen, medium shrub fen, sub-boreal dwarf-shrub fen, circumneutral-patterned fen, spruce-fir swamp, black spruce wooded

bog, and black spruce-larch swamp. Distinctions among those community types are based upon water levels and pH as well as the extent of shrub layer present, and typically are classified as peatlands (see sidebar).

In addition to the rare and unique plant communities described below, these peatland complexes support many northern breeding species, including rusty blackbird, palm warbler, and mink frog. The peatlands also support diverse amphibians, including spring peeper, gray treefrog, bullfrog, American toad, and northern leopard, green, pickerel frog and wood frog.

On the western side of Umbagog Lake is an 870-acre peatland complex encompassing four areas: Leonard Marsh, Sweat Meadow, Harper's Meadow, and Chewonki Marsh. A 750-acre portion of the complex, known as "Floating Island Bog," was designated as a National Natural Landmark in 1972 (Nazaire 2005). Leonard Marsh and Harper's Meadow form an extensive acidic fen complex with a pH of 4.0–4.7. Fens differ from marshes and streamside meadows by the absence of mineral soils at the surface and the presence of peat deposits and extensive layer of Sphagnum moss. These areas and associated wetlands form one of the largest peatland complexes in New Hampshire. This acidic fen complex harbors a high diversity of vascular plants, mosses, and liverworts. For example, the NHNHB found 16 species of Sphagnum moss at Sweat Meadow (Sperduto 1999).

The Leonard Marsh-Harper's Meadow peatland complex consists of a unique suite of open and wooded types identified by Sperduto (1999):

- extensive, open floating moss lawns dominated by aquatic Sphagnum sp. (e.g., Torrey's sphagnum and Golden Bog-moss)
- moss carpet fens dominated by non-aquatic Sphagnum species (e.g., peat moss) and dwarf and medium-height heath shrubs
- moss carpet fens dominated by sedges (such as few-seeded sedge, quagmire sedge, and other unique "bog plants" such as pod-grass
- various mixes of black spruce-larch woodlands and sparse woodland fens dominated by heath shrubs and Sphagnum mosses.

Nazaire (2005) conducted a floristic inventory and vegetation analysis of the 452-acre Leonard Marsh from 2002 to 2004, documenting 14 community types and several rare plants, including narrow-leaved cotton-grass, heart-leaved twayblade, and creeping sedge. Peat depths in Leonard Marsh ranged from 26 to 92 inches (Nazaire 2005).

Floating Island National Natural Landmark
In 1972, the Secretary of the Interior designated part of the wetlands at Harper's Meadow as an NNL. That designation recognizes the floating bog and wetlands as a significant natural area, one of a very special group of places illustrating the diversity of the country's natural history (Favour 1971). The National Park Service administers the NNL program, which is a voluntary program for landowners (USDOI 1999). The current size of the NNL is 860 acres (map 2-1).

A rare fen of high regional significance, the circumneutral-patterned fen is found near the center of Tidswell Point. Most of that fen is on land owned by the State of New Hampshire as part of the Umbagog State Park, and a portion is on the refuge. The pH in the fen ranges from 6.3 to 8.4. Only a few locations in New England of this natural community type are known. Patterned fens consist of long, linear, raised hummocks and intervening low hollows. Circumneutral fens, typically part of larger peatlands, are calcium-enriched from groundwater,

supporting a characteristic set of plant species that are often rare. A large, high-quality northern white cedar swamp surrounds the fen (Sperduto 1999).

The patterned fen hummocks are dominated by stunted and heavily browsed northern white cedar. The hollows support several rare plants, including meager sedge, livid sedge, thin-flowered sedge, and moor rush. Other rare and uncommon plants growing in the fen include the state-listed endangered dragon's mouth and the state-listed threatened Pursh's goldenrod, cotton bulrush, orchids rose pogonia, and grass pink (Sperduto 1999).

The southern side of the more eastern Whaleback Pond supports an open floating bog mat dominated by Sphagnum rubellum, scattered dwarf heath shrubs, pitcher plants, and several other mosses (Sperduto 1999).

Black spruce wooded bog composes part of the large peatland complexes. Tree canopy cover of black spruce, larch, and hemlock varies from 10 percent to 60 percent. Shrub cover, dominated by Labrador tea and rhodora, reaches 80 percent. Sphagnum covers nearly the entire wooded bog. In addition to being part of the Floating Island, black spruce wooded bog occurs around Mountain Pond and Tidswell Point. Black spruce-larch swamp has many of the same species as the wooded bog, although it is not typically part of the large peatland complexes (Rapp 2003).

Northern White Cedar

Northern white cedar forest covers 4 percent (829 acres) of the refuge. The natural communities in this grouping all have northern white cedar (nwc) as a dominant plant. The communities include nwc-balsam fir peatland swamp, nwc-black ash swamp, nwc-boreal conifer mesic forest, nwc-peatland swamp, nwc-seepage forest, and nwc-wooded fen. These soils are typically moist to saturated peat or muck, and are highly to moderately acidic. Examples of northern white cedar communities on the refuge are in areas north of Whaleback Ponds, downstream of Mountain Pond, and above the outlet of the Dead Cambridge River into the lake.

Northern white cedar is a boreal species that occurs as far south as Carroll and Grafton counties in New Hampshire. The NHNHB considers northern white cedar swamps a "signature-community" of the north woods, and hence, an important component of the region's biodiversity (Sperduto and Engstrom 1998). The largest northern white cedar swamp in New Hampshire (80 to100 acres) surrounds the Whaleback Ponds and extends toward the Magalloway River. This wetland basin lies within the refuge acquisition boundary, but only a portion is now under Service ownership. The acidic cedar swamp is large, uniform, and largely undisturbed, with an abundance of Sphagnum moss, shrubby understory and slightly stunted canopy cedars, and is 120 to 200 years old (Sperduto 1999).

The NHNHB identified a 20-acre mixed hardwood-conifer seepage swamp in a shallow bedrock basin that empties into Umbagog Lake near Thurston Cove. The seepage swamp contains a large amount of northern white cedar around the margins of a boreal dwarf shrub fen. The swamp shows evidence of past logging, but is currently more than 200 years old (Sperduto 1999).

Several northern bird species use this habitat type year-round, including boreal chickadee, gray jay, and spruce grouse. White-tailed deer find cover and forage in the northern white cedar. A dusky salamander was recorded from a cedar swamp near Harper's Meadow during a 1999–2002 amphibian and small mammal survey in cedar swamps and riparian habitats. American toads were abundant in that survey, and other amphibians were detected in the cedar swamp, including wood and green frogs, spotted and blue-spotted salamanders, spring peepers, and eastern newts. A diversity of small mammal species were identified in the

cedar swamp habitat, including masked, northern water and short-tailed shrews, southern red-backed voles, and several bog lemmings (species unknown).

Bill Zinni/USFWS

Scrub-shrub habitat on refuge

Scrub-Shrub Wetlands

Scrub-shrub wetlands cover 3.2 percent (655 acres) of the refuge. Scrub-shrub is found in areas that are seasonally flooded, such as riparian areas, floodplains, or around the edges of beaver-flooded wetlands in patches that average 7.5 acres. The natural community types are speckled alder peatland lagg, (speckled, green) alder shrubland, speckled alder swamp, and sweetgale mixed shrub thicket. Shrub cover dominates those areas, with speckled alder, sweetgale, and leatherleaf as the most common species. Trees generally are absent or very sparsely distributed; if present, they typically include balsam fir and red maple. Sphagnum, ferns, dwarf black berry, sedges, and grasses dominate the understory. Soils vary from strongly to moderately acidic.

The largest example of alder shrub land is in the floodplain of the Dead Cambridge River above its confluence with the Swift Cambridge River. Smaller examples are in cut-off oxbows located along the Magalloway, Rapid, and Androscoggin rivers (Rapp 2003).

Beaver, American woodcock, and Canada warbler are wildlife species associated with scrub-shrub habitat.

Open Water and Submerged Aquatic Vegetation

Open water, floating-leaved, and submerged aquatic vegetation habitat includes the aquatic bed (submerged lands extending from the current shoreline to the pre-dammed lake shoreline; or, the lake shoreline prior to impoundment) In addition, open water habitat includes the riverbeds and small ponds. Open water or submerged lands of the original Great Ponds in both Maine and New Hampshire are not included and are owned by the respective states. Open water and submerged and floating-leaved aquatic vegetation on the refuge encompasses 24.5 percent (5,033 acres) of current refuge ownership.

Umbagog Lake is the second largest lake in New Hampshire. Its average depth is 15 feet. It includes extensive shallow areas with unconsolidated bottom, a reflection of the historical conditions that created much of the lake: that is, the flooding of low-lying forest. Two deeper pools of more than 50 feet lie near the mouth of the Rapid River and off the northern cliffs of Sturtevant Cove (Van de Poll 2004).

Umbagog Lake is largely homothermous—the same temperature from top to bottom—creating warm summer temperatures (Boucher 2005). However, Umbagog Lake is important wintering habitat for native brook trout from the Diamond River watershed (Diane Timmons, NHFG, personal communication, 2004) and from the Rapid River. Smallmouth bass were introduced illegally into Umbagog Lake during the mid-1980s, and have since migrated to other connecting waters, including the Rapid River. Smallmouth bass, introduced into New Hampshire in 1865, are predators and competitors of brook trout (Boucher 2005).

We have very little information on the refuge open water habitat that is composed of the river tributaries and ponds. We have not conducted any bathymetry or water chemistry studies, nor have we conducted any fish or aquatic invertebrate studies. Our only wildlife study in this habitat was a stream salamander survey in a few locations in 2001 and 2002. Two-lined salamanders were abundant at those sites. A spring salamander was recorded in Bull Moose Stream at the southern end of the lake. A dusky salamander was reported in a stream flowing into Mountain Pond.

Wooded Floodplain
Wooded floodplain covers 5.5 percent (1,140 acres) of the refuge. Found primarily along the Magalloway, Dead, and Swift Cambridge rivers, its natural communities include red maple floodplain forest, red maple-balsam fir floodplain forest, white spruce-balsam fir berm woodland, red maple-tussock sedge floodplain woodland, black ash-mixed hardwoods, and red maple-black ash swamp. Red maple, silver maple, and balsam fir dominate the closed to intermittent canopy along with yellow birch and white spruce. Red maple floodplain forest approaches its northern limit on the Magalloway River.

The entire Magalloway River shoreline offers the best example of the wooded floodplain forest community on the lake. The NHNHB lists it as a good example of a "balsam fir floodplain forest" community type.

The wooded floodplain supports a rich diversity of wildlife, including cavity-nesting ducks (e.g., wood duck, common goldeneye, common and hooded merganser), nesting songbirds (e.g., rusty blackbird, northern parula), and foraging waterfowl (e.g., black duck). Large floodplain trees offer perching sites for bald eagle, osprey, belted kingfisher, and other birds. It also supports a rich diversity of amphibians, including mink, wood, green and pickerel frog, spotted and blue-spotted salamander, American toad, spring pepper, eastern newt, and bullfrog.

Woodplain floodplains also host several bat species, including little brown, hoary, and northern long-eared bats. Those bats roost in tree cavities, under loose bark or dense foliage (DeGraaf and Yamasaki 2001). Other small mammals detected in this habitat were masked, short-tailed and smokey shrews, southern red-backed vole, meadow jumping mouse, eastern chipmunk, and a bog lemming (species unknown).

Lakeshore Pine-Hemlock Forest
Lakeshore pine-hemlock forest covers 1.1 percent (232 acres) of the refuge. Natural communities in this habitat type include hemlock mesic forest, hemlock-hardwoods forest, hemlock-white pine-red spruce forest, red pine-white pine forest, and jack pine-blueberry-feathermoss forest. The canopy layer in each of those plant associations is dominated by varying mixtures of conifers (white pine, hemlock, red pine, red spruce, jack pine); all occur on well-drained to excessively well-drained soils, typically near lakeshores.

Some of the best examples of the lakeshore pine-hemlock natural communities occur along the lake near Tyler Point, Big Island, and Tidswell Point, as pines dominate the eastern shore of Umbagog Lake. The jack pine-blueberry-

A little brown bat

USFWS

feathermoss community occurs in small groups or as individuals along the lakeshore.

Jack pine is rare in New Hampshire, where it grows at the southern limit of its range (NH S1 rank). This community is the only low-elevation occurrence of this type in New Hampshire.

A northern occurrence of hemlock mesic (moderately moist) forest is found along the lake on Tyler Point.

Many of the large, mature, "super-canopy" trees are in the lakeshore pine-hemlock habitat. Their size and proximity to open water makes them ideal nest trees for bald eagle and osprey. Sharp-shinned hawk, merlin, and olive-sided flycatcher are a few of the other species that nest in this habitat.

Upland Habitats

Forests are the dominant landscape type in northern New England, and 90 percent of the Upper Androscoggin River watershed that encompasses Umbagog Lake is a mixed forest matrix as described above. However, it is important to note that the mixed forest matrix of today supports more hardwoods than over the last 150 years (Cogbill, personal communication, 2004). That reflects a forest composition affected by multiple cycles of timber harvesting. Selective harvesting of softwoods has converted many spruce-fir stands to mixed stands, and mixed stands to hardwood stands. In the absence of further human disturbance, these forests, through natural succession and disturbance patterns, will shift to a higher proportion of softwood (Publicover and Weihrauch 2003). That prediction is also consistent with the site capabilities of the refuge expressed through the ecological land units (a combination of elevation, bedrock geology, and topography).

As we mentioned previously, three broad upland habitat types embedded in the mixed forest matrix are found in varying amounts: spruce-fir, northern hardwoods, and mixed wood. These three habitat types encompass 48 percent (9,913 acres) of the refuge.

Spruce-Fir
The spruce-fir habitat type covers 9.5 percent (1,947 acres) of the refuge. Natural communities in this habitat type include lowland spruce-fir forest, red spruce rocky summit, and black spruce-red spruce forest.

This spruce-fir habitat type is dominated by red spruce, balsam fir, and paper birch. Other typical plant associates include lowbush blueberry, mountain ash, American fly-honeysuckle, bunchberry, wood sorrel, wild sarsaparilla, and bluebead lily, among others. Logging heavily affected the lowland spruce-fir community type, and large areas now mapped as successional spruce-fir forest or recently disturbed will likely shift to spruce-fir over time. The largest remaining stands grow on gentle slopes and flats in the Mountain Pond, Sunday Cove, Whaleback Ponds, Mile Long West, and Dead Cambridge areas (Rapp 2003).

Red spruce and balsam fir are both late successional, shade tolerant, and shallow rooted. Balsam fir is an abundant seed producer, is highly susceptible to heart-rot, and is at risk from wind damage and uprooting. Fir is the preferred host of spruce budworm, and is affected by balsam wooly adelgid. Spruce budworm outbreaks occur on 40- to 70-year cycles, although outbreaks may have been less frequent historically when balsam fir was less abundant. The life span of fir ranges between 40 and 70 years, depending on site conditions. Red spruce seeds infrequently, and is highly resistant to decay, resulting in a long life span (300+ years) (Seymour 1992).

The black spruce-red spruce community type is difficult to distinguish from the lowland spruce-fir. It occurs along wetland borders, and is dominated by red and black spruces. The canopy is typically quite dense, with little understory; mosses dominate the forest floor. The "fairy forest" near Sunday Cove is a good example of this type. Disturbed versions of this community type, such as the moose wallow 1.5 miles northeast of the refuge headquarters, typically have little spruce, and are instead dominated by balsam fir or larch (Rapp 2003).

The red spruce rocky summit community type is uncommon and restricted to ridge tops and steep, rocky slopes such as in the Errol Hill, Mile Long, and Whaleback Pond areas. Soils are usually acidic, and outcrops are evident. Red spruce is the dominant species, with lesser amounts of balsam fir and paper birch (Rapp 2003).

Lowland spruce-fir is important for a range of wildlife species that depend on it for nesting habitat and winter cover. Softwood-associated bird species include bay-breasted, Cape May and blackburnian warblers. Many other songbirds occur in this habitat including 13 other warblers: magnolia, northern parula, black-and-white, Canada, black-throated blue, American redstart, common yellowthroat, Nashville, black-throated-green, yellow-rumped, chestnut-sided, yellow, and northern waterthrush. Other bird species of note that appear here include hermit and Swainson's thrushes, veery, winter wren, yellow-bellied flycatcher, yellow-bellied sapsucker, and swamp sparrow.

The spruce-fir habitat type supports some of the most important deer wintering areas. Bobcats use the conifer-dominated ridge tops, and martens are common inhabitants of spruce-fir.

Mixed Woods

The mixed conifer-hardwood habitat type covers 17 percent (3,478 acres) of the refuge, and includes red spruce-hardwood forest, successional spruce-fir forest, and aspen-fir woodland natural community types. The communities are distinguished primarily by the dominant canopy species that in turn are influenced in large part by specific site conditions and disturbance history.

This habitat type is the most widely distributed habitat type on the refuge, occurring on all but the highest elevations. It is especially prevalent in the Errol Hill, Mile Long, Whaleback Ponds, and Sunday Cove areas. In addition to red spruce, the dominant plant species include yellow birch, red maple, striped maple, and woodfern. Sugar maple and American beech are often present in this mixed woods habitat type. The successional spruce-fir forest type usually develops after disturbance to lowland spruce-fir. It usually has fewer northern hardwood species present with red spruce and balsam fir dominant in the understory. This community will typically succeed to lowland spruce-fir. Aspen-woodland is dominated by quaking aspen and balsam fir. It is most common around Mountain Pond but found in small patches throughout the refuge on lower slopes with well-drained loam soils (Rapp 2003).

This habitat type supports species that depend on a combination of hardwood and softwood tree species such as blackburnian and black-throated green warbler, or utilize a successional stage of this habitat such as Canada warbler and American woodcock. Mixed woods support many of the species mentioned under spruce-fir but in higher numbers.

Northern Hardwood

The northern hardwood habitat type covers 21.9 percent (4,488 acres) of the refuge. The natural community types include northern hardwood forest, semi-rich northern hardwood forest, early successional aspen-birch forest/woodland,

red maple-yellow birch early successional woodland, and paper birch talus woodland. These hardwood forests are dominated by sugar maple and yellow birch, with other common species including American beech, red spruce, striped maple, hobblebush, and woodfern.

Northern hardwoods occur on well-drained loam soils at mid elevations. The forests typically have a closed canopy with variable shrub and herbaceous layers depending on local conditions and disturbance history. Most of the northern hardwoods were logged once or more in the past. It is found throughout the refuge, with good examples on the eastern slopes of Errol Hill and Mill Mountain, on Tyler Point, south of the Whaleback Ponds, and at the base of C Bluff cliff. A small patch of the semi-rich northern hardwood forest occurs in the vicinity of C Bluff; small pockets of enriched soils occur within northern hardwoods elsewhere on the refuge (Rapp 2003).

The aspen-birch woodland types become established after logging or some other disturbance. The early successional aspen-birch woodland is dominated by quaking aspen or paper birch with high shrub density including beaked hazelnut and several viburnum species. Occurrences on the refuge include the Dead Cambridge, Tidswell Point, Mountain and Mile Long ponds, areas where logging has occurred in the last 50 years. A similar early successional type is one dominated more by red maple and yellow birch. This occurs in the Whaleback Ponds, Mile Long and Mountain ponds, on Big Island, and near the eastern lakeshore (Rapp 2003).

The paper birch talus woodland is a single occurrence at the base of C Bluff. Paper birch is growing on a stabilized granite boulder talus with slopes between 30 percent and 45 percent. Soils are thin and patchy. Shrub cover is high and dominated by mountain maple. These talus slopes provide denning habitat for mammals including porcupine and bobcat. A peregrine falcon was heard from in the C Bluff area, one of the largest cliffs in the area (Rapp 2003).

The northern hardwood habitat type is important to landbird species of concern such as black-throated-blue warbler, American woodcock, and Canada warbler. Black-throated blue warbler nest in hobblebush and other understory vegetation, while American woodcock and Canada warbler utilize the early successional stages of these same forest types. This type also supports high numbers of many common nesting songbirds, including red-eyed vireo, ovenbird, hermit thrush, winter wren, scarlet tanager, and yellow-bellied sapsucker.

Recently Harvested
Recently harvested, or early successional (disturbed) forest, covers 4.6 percent (938 acres) of the refuge. This community is more ephemeral than most others, because it has experienced recent disturbance, usually in the form of logging. One particularly notable example of this type covers much of the upland areas of Tidswell Point. We are not actively managing any of the upland cover types now. These early successional stages, as noted above, are important to a suite of species such as woodcock, chestnut-sided warbler, morning warbler, white-throated sparrow, and snowshoe hare. The latter is an important food source for lynx, bobcat, and other mammals.

Fields and Residences
Fields and residences cover 0.5 percent (107 acres) of refuge lands. These areas are actively maintained for human residential or commercial purposes, including buildings, lawns, and other development. The Potter Farm and the Chapel Hill Road community are two examples. These areas are maintained for administrative purposes and provide little or no wildlife habitat value.

Marvin Moriarty/USFWS

The former Potter Farm is now part of the refuge

Rare or Unique Habitat Types and Rare Plant Populations

Several rare or unique habitat types and rare plant populations are not displayed in this document because their small size does not show up in relationship to the map scale used for the other habitat types, or because the refuge has not identified all their specific locations. These areas include vernal pools (see discussion below) and other small, uncommon wetlands, cliffs, and talus slopes (see northern hardwoods discussion). In addition, appendix B lists more than 30 species of rare plant populations known on the refuge and their state status. Digital information on those rare habitat types and plant species we have mapped can be obtained at refuge headquarters.

Vernal Pools

A vernal pool is a small water body lacking a permanent aboveground outlet. In the northeast, vernal pools fill with winter snowmelt, spring rains, and autumn rains. They typically dry by mid to late summer or earlier in drought years. How long water stays in a vernal pool is known as its hydroperiod, which varies depending on the pool and the year. A vernal pool, because of its periodic drying, does not support breeding populations of fish. Vernal pools on the refuge provide essential habitat for several obligate amphibian species, including blue-spotted and spotted salamanders and wood frog, contributing to refuge biodiversity. Maintaining vernal pools with a range of hydroperiods is important in sustaining vernal pool biodiversity. Most of the vernal pools on the refuge are embedded within the floodplain and riparian habitats.

Invasive Plants

We have not carried out any systematic surveys for terrestrial or aquatic invasive plants. However, our staff and interns are continually on the lookout for these plants. We have mechanically treated or hand-pulled Phragmites, purple loosestrife, and Japanese knotweed from localized areas, often where fill has been brought in. Examples of areas we have treated include the refuge headquarters parking lot, the Magalloway River Trail, and skid roads.

We are not aware of any aquatic invasive plants, but continue to be vigilant for the presence of non-native milfoil.

Fish and Wildlife

The refuge's diverse assemblage of upland and wetland vegetation—the lake, the Androscoggin and Magalloway rivers, and many other ponds and streams—hosts a wide variety of terrestrial and aquatic animal species described below.

Federal- and State-Listed Wildlife Species

There are no federally listed species on the refuge, since the bald eagle was de-listed in 2007. Bald eagles nested near Umbagog Lake during the first half of the 20th century, but there was no successful nesting in the area from 1950 though 1988. One breeding pair established a nesting territory on the northern half of the lake in 1989. In 2000, biologists confirmed that a second breeding pair had established a territory on the southern half of the lake (Martin 2001). The refuge and surrounding area also support non-breeding immature bald eagles year-round. This includes some individuals migrating from as far away as Florida; those were tracked using satellite technology. For more on bald eagles, see below.

Thirteen bird species known to use the refuge are on the Maine or New Hampshire state lists of endangered and threatened wildlife (table 3.8). One species of New Hampshire threatened mammal has been confirmed to occur on the refuge.

Table 3.8. Maine and New Hampshire State-listed species that occur or likely occur on the refuge

BIRDS	STATE STATUS
American pipit	Endangered in ME (proposed breeding population only)
American Three-toed woodpecker	Threatened in NH
Bald eagle	Endangered in NH (proposed Threatened), Threatened in ME
Black tern	Endangered in ME
Common nighthawk	Threatened in NH
Common loon	Threatened in NH
Common nighthawk	Threatened in NH (proposed endangered)
Common tern	Endangered in NH (proposed Threatened)
Cooper's hawk	Threatened in NH (proposed de-listed)
Golden eagle	Endangered in both NH and ME
Northern harrier	Endangered in NH
Osprey	Threatened in NH
Peregrine falcon	Endangered in NH (proposed Threatened), Endangered in ME
Pied billed grebe	Endangered in NH (proposed Threatened)
MAMMALS	
American marten	Threatened in NH
Northern bog lemming	Threatened in ME
Small-footed myotis	Endangered in NH

Birds

Written documentation on bird populations in the Umbagog Lake area extends back more than 130 years. Noted 19th-century ornithologist William Brewster spent extensive periods studying the birds of the area from 1871 through 1909 (Brewster 1924). Observations from the past 55 years by an increasing number of professional and amateur ornithologists contribute to a general understanding of local bird populations: for example, a series of periodicals published under various names by the ASNH from 1921 to1982, the National Audubon Society's Christmas Bird Count data for Errol, New Hampshire from 1958 to 2003, and the New Hampshire Bird Records database from 1982 to 2003. Our refuge bird list includes 229 species that have been observed on the refuge during one or more seasons.

In 1980, the NHFG and the ASNH initiated a statewide cooperative endangered and threatened species bird monitoring and management program (Robinson 1999). The Umbagog Lake area was included in the monitoring particularly for common loon, pied-billed grebe, bald eagle, osprey, peregrine falcon, and northern harrier.

Waterfowl

The refuge is unique in the region for the diversity of waterfowl that breed here. Umbagog Lake marshes and backwaters, forested and shrub wetlands, and adjacent forested and cutover uplands provide important nesting and brood-rearing habitat for such waterfowl as black duck, ring-necked duck, and cavity-nesters including common goldeneye, wood duck, common merganser, and hooded

merganser. The refuge supports the highest concentrations of nesting black and ring-necked ducks in New Hampshire (USFWS 1991). Blue-winged teal, green-winged teal, and mallard also nest in the area. It is one of three high priority waterfowl focus areas in New Hampshire (Atlantic Coast Joint Venture 2005). Ducks are most commonly observed in backwaters along the Magalloway and Androscoggin rivers, Leonard Pond, Leonard Marsh, Harper's Meadow, Sweat Meadow, Chewonki Marsh, the outlet of Umbagog Lake and, to a lesser extent, in Tyler Cove and near the outlet of the Dead Cambridge River.

Umbagog Lake is also an important migratory staging area for the waterfowl mentioned above, as well as for greater and lesser scaup, bufflehead, white-winged, surf and black scoters, and Canada and snow geese. The NHFG surveys waterfowl on the refuge annually, just before the duck-hunting season opens. We also conducted a few limited fall waterfowl surveys from 2000 to 2002.

In 1940, the most common nesting waterfowl on Umbagog Lake (in order of abundance) were goldeneye, black duck, common merganser, wood duck, hooded merganser, and blue-winged teal (Provost 1940). That survey reports goldeneye and common merganser as common ducks on the Androscoggin River above the Errol dam, and goldeneye, black duck and wood duck as the most common species in Harper's Meadow. According to Provost (1940), waterfowl were more abundant during the 1920s, when local hunting clubs planted wild rice around the lake. In 1940, emergent vegetation around the lake (presumably Leonard and Chewonki Marshes) produced an average of one duck per 1.5–2 acres (Provost 1940).

Although we have no quantitative data on nesting waterfowl, our observations indicate that the most common species in recent years are black ducks, common and hooded mergansers, and ring-necked ducks. This information is also based partly on waterfowl species observed during a general refuge breeding bird survey by Bob Quinn in 1999 and 2000.

Common Loon

Umbagog Lake supports one of the highest concentrations of breeding common loons in New Hampshire. However, it falls below other lakes in terms of hatching success, chick survivorship, and overall productivity (Taylor et al. 2004). In recent years, the number of territorial pairs on the lake is around 17. Loons arrive on territories as early as mid-May, particularly on the rivers. The nesting season of common loons on Umbagog Lake starts around May 20. In most years, the majority of nests are established between June 1 and June 20. Hatching generally occurs between July 1 and July 20.

The most productive loon territories, located primarily on the north end of the lake, are the Magalloway River, Harper's Meadow, Sweat Meadow, Pine Point and Sunday Cove. Moderately productive sites include Sturtevant Cove, Leonard Marsh, Leonard Pond, and Southeast Arm, at the southeast end of the lake. The least productive sites include Sargent Cove, B Brook, and Thibodeau, south of Sunday Cove.

In 1985, a water management agreement among the owners of the Errol dam and conservation agencies and organizations reduced the rate of water level change during the loon-nesting season (see hydrology discussion, page 3-20). In addition to managing water levels, buoy lines and educational signs are employed to minimize disturbance and promote increased hatching success. Artificial nesting rafts were deployed in the 1970s to increase productivity; however, those have since been removed, with the shift toward natural nesting structures.

The LPC has intensively monitored the loon population since 1976. Productivity was low at that time due to frequent flooding during the nesting season. The number of loon nesting territories increased from 9 in 1976 to 32 in 2000 around

the Umbagog Lake and on the Magalloway and Androscoggin rivers. The number dropped to 16 territorial pairs in 2002. Comparable declines were not observed on nearby lakes during the same period. Since then, the numbers have fluctuated around 18 to 20 territorial pairs: in 2003, 19; in 2004, 20; and in 2005, 20. The cause(s) of the 2000 to 2002 decline have not been identified. A dozen or so unpaired adult birds are on the lake each year as well.

Although 20 or more loon pairs establish territories on Umbagog Lake and its tributaries in a given year, 75 percent or less actually nest, and many fewer hatch chicks successfully. In 2005 for example, of 20 territorial pairs, 13 nested. Of those nesting pairs, six pairs successfully hatched a collective eight chicks and only four of those survived. Predation on eggs and chicks was the primary cause of nest failure. Raccoon, mink, fisher, herring gull, bald eagle, and raven are known to prey on loons; mammalian predation is the most prevalent (Taylor et al. 2005).

More than 75 individual common loons were banded and sampled for contaminants between 1993 and 2003 as part of a regional study on common loon reproduction and blood chemistry. Two loons were equipped with radio transmitters in 2003. Both of those birds migrated to the coast of Maine in the fall: one near Saco Bay and the other near Penobscot Bay. Another bird was equipped with a transmitter in 2004, and has also migrated to the coast of Maine to Muscongus Bay. Another 14 loons were captured, banded, and color-marked in 2005, and 12 loons were evaluated for eight different avian diseases (Yates and Evers 2005).

In 2002, the cause of death of three loons in Umbagog Lake was attributed to lead poisoning from ingesting lead sinkers. At least one loon was also infected with the West Nile virus. Blood samples from Umbagog Lake loons were analyzed for methylmercury, and were found to contain moderate levels lower than other reservoirs in the Rangeley Lakes chain. The highest mercury concentrations on the refuge were in loons nesting on the Magalloway River and in the southeastern section of Umbagog Lake (Biodiversity Research Institute 1998). Moderately high levels were also found in Leonard Pond, Potter Cove, Black Island Cove, Absalom, and Gull Island birds. The lowest levels of mercury were in birds on the Androscoggin River. Mercury levels were higher in males than in females. The Magalloway River flows out of Lake Aziscohos, which has high mercury levels (ECSMarin 2003).

Common snipe

Marsh Birds

Marsh birds, including American bittern, Virginia rail, sora, Wilson's snipe, and pied-billed grebe breed in the marshes and other wetlands on the refuge. Two non-active great blue heron nests were reported on the refuge in 2002. Umbagog Lake is one of just a handful of locations in New Hampshire where the black tern is observed repeatedly during the breeding season, although no nests have been confirmed.

Volunteers using taped broadcast callbacks surveyed breeding marsh birds annually on the refuge from 1999 to 2002. Surveys were conducted along three transects: one each along the Dead Cambridge River, in Leonard Marsh/ Leonard Pond/Chewonki Marsh, and one in Harper's and Sweat Meadows. The most common targeted marsh birds recorded were Wilson's snipe, Virginia rail, American bittern, and alder flycatcher. Sora, pied-billed grebe, marsh wren, and belted kingfisher also were noted. Other birds that forage or nest in the wetlands were recorded on this or other surveys; they included common yellowthroat, great blue heron, Lincoln's sparrow, northern waterthrush, palm warbler, red-winged blackbird, rusty blackbird, and swamp sparrow.

Common terns have been observed perching on exposed rock outcrops on the lake both historically and in recent years. However, those records involve small groups of migrating or non-breeding individuals. They do not indicate that this species has ever attempted to breed in the Umbagog Lake area (Brewster 1924).

Shorebirds

Shorebirds migrate through the refuge mid- to late April through mid-June (spring) and late August through early to mid-November (fall), congregating in relatively low numbers on the margins of wetlands. Only a few species of shorebirds are known to breed on or near the refuge, including spotted sandpiper, Wilson's snipe, and American woodcock. We have not conducted woodcock surveys; however, in 2006 we plan to establish singing ground surveys on the refuge to gain additional information on their breeding status.

We conducted a few limited spring and fall shorebird surveys from 2000 to 2002. Bob Quinn compiled a list of shorebird sightings on the refuge from 1990 to 1998. The most common species are Wilson's snipe, spotted sandpiper, greater yellowlegs, solitary sandpiper, and killdeer. During migration, large mixed flocks are sporadically seen feeding on the exposed mud flats that appear when the water levels are low. Other migrant shorebirds that are seen on rare occasions include semi-palmated and black-bellied plover, red-necked phalarope, red knot, semi-palmated and least sandpipers, dunlin, short-billed dowitcher, Wilson's phalarope, and lesser yellowlegs (Quinn 2005).

Bald Eagle

Bald eagles were absent from the refuge between 1949 and 1989, a result of widespread use of DDT that caused major population declines across their range. The bald eagle made a remarkable recovery, along with many other raptors, after DDT was banned and the eagle was protected on the Endangered Species List. Since 1980, ASNH, through a contract with the NHFG, has monitored bald eagles and ospreys in New Hampshire.

Nesting bald eagles returned to Umbagog Lake in 1989, after a more than 30-year absence. In 1989, a pair nested in a live white pine tree on an island in Leonard Pond on the refuge, near the confluence of the Magalloway and Androscoggin rivers. That nest was continuously occupied until 1994. In 1994, the pair moved to a tree on Pine Point on the eastern shore of the lake. That year, the adult male eagle died, apparently from ingesting lead shot, and the Pine Point nest failed. The remaining adult female paired with another male and re-established the nest at the Leonard Pond site. That nest has continued to be occupied each year from 1994 to 2004. From 1990 to 2002, the nest produced an average 1.2 chicks/year. During that 12-year period, nest failures occurred four times (i.e., no chicks fledged): in 1994, 1997, 2000, and 2002. By 1992, the original nest tree had died, although nesting continued in the snag that remained. In 2002, the eagle pair dismantled the Leonard Pond nest, but remained in the vicinity. A mate change apparently occurred in 2001 (new male), and in 2003 the female was replaced. No eggs hatched successfully in either 2003 or 2004 (ASNH unpublished data).

In 2000, a second pair established a nest on the east side of the lake in a white pine tree on Tidswell Point, approximately half a mile inland from the lake. That nest produced two chicks in 2000, one chick in 2001, one in 2002, two in 2003, (only 1 of these survived to fledging), and two in 2004. In 2006, a third pair established a nest in Sweat Meadows and successfully fledged 2 young in 2007.

The refuge eagles likely remain in the general vicinity of the refuge year-round. The adult male was confirmed on or near the lake every month of the year except January (ASNH unpublished data).

The Leonard Pond eagles generally forage around the north end of the lake, from Errol Dam to the Rapid River and southeast to Tyler Cove. The Tidswell Point eagles were observed foraging primarily around the southern end of the lake. In 2005, ASNH documented three territorial pairs of eagles, although only one nest was successful: two young fledged. A varying number of immature eagles are also observed from time to time on the lake and rivers during the breeding season (Martin et al. 2006).

Umbagog Lake breeding eagles start nest building in March, and start incubating in early April. One to two eggs hatch around May 6 through May 22, and the young fledge between July 30 and August 17. Eagle fledglings typically disperse from mid-September to early October.

Public access to the Leonard Pond nest is restricted by buoys and signs placed about 500 feet away from the nest. Buoys are left out from shortly after ice-out through the end of October (ice-out on Umbagog Lake averages around May 2). Predator guards were installed on both the Leonard Pond and Tidswell nest trees. In 1990, ASNH surveyed boat activity around the Leonard Pond eagle nest during May through August. Visitation reached a high of 133 boat approaches to the nest site in one day (349 people). The highest visitation rates occurred on Saturdays (mean of 6.6 boats/hour) and on August weekends (mean of 9.4 boats/hour). Lowest levels of visitation were in June (mean of 3.3 boats/hr). The majority of the visitors obeyed the closure signs, although a few canoeists violated them. ASNH also observed some visitors attempting to feed fish to eagles (ASNH unpublished data).

Osprey

USFWS

Osprey

Ospreys were considered common summer residents around Umbagog Lake as far back as the late 1800s. Populations across the eastern United States declined precipitously beginning in the 1950s, and by the late 1970s, just three or four breeding pairs remained in the entire State of New Hampshire, all of which were located near the refuge.

Since 1980, ospreys have monitored by ASNH, NHFG, or the refuge. Within the refuge acquisition boundary, approximately 23 nest site locations are recorded for osprey over the past 20 years. However, in the past 10 years, a gradual decline was noted in the number of osprey pairs nesting within the four townships surrounding the refuge: Cambridge, Errol, Second College Grant, and Wentworth Location (Martin 2002). The factors contributing to that apparent local decline have not been completely identified. At the same time, osprey populations elsewhere in New Hampshire are increasing. An apparent decrease in active nests in the Umbagog Lake area occurred from about 1996 to 2001, and was followed by an apparent increase in 2002 (Martin et al. 2006).

In 2006, there were 11 territorial pairs of osprey engaged in active nesting attempts, and 15 fledglings were produced. The majority of nest trees have had predator guards placed around the bottom of the tree.

Other Raptors

Peregrine falcons, although never common in the area, were eliminated from their historical breeding sites in both Maine and New Hampshire, including several areas near Umbagog Lake, by the late 1950s. Four historical nesting cliffs are within view of the lake, likely chosen by peregrines for their proximity to a good food supply of ducks, shorebirds, and songbirds. Today, the lake, marshes, and other open areas on the refuge provide stopover habitat for migrating peregrines passing through the area in both the spring and the fall.

Confirmed intermittent sightings of individual golden eagles continue in areas near the refuge, mostly during migration and in winter, typically associated with

a temporary local abundance of carrion. For several decades, the Umbagog Lake area annually has supported from one to five breeding pairs of northern harriers. Cooper's hawks are longtime occupants of the Umbagog Lake area (Brewster 1924), and merlins are regular nesters on the refuge.

Other Birds

The upland forests and diverse wetland communities on the refuge support more than 100 breeding species of songbirds, and offer stopover habitat for dozens more during migration. The peatland communities in particular support a suite of birds with boreal forest affinities, such as gray jay, spruce grouse, black-backed woodpecker, and palm warbler, which approach their southern range limits in this area. Other northern coniferous forest birds known to breed on the refuge include pine grosbeak, white-winged crossbill, and red crossbill.

Bird surveys conducted on the New Hampshire side of the refuge from 1999 to 2004, mostly within the mixed woods and hardwood floodplain, recorded more than 40 bird species, including several species of conservation concern: ovenbird, black-throated-blue warbler, American redstart, veery, yellow-bellied sapsucker, black-throated-green warbler, Nashville warbler, and northern parula. In 2005, we established five additional transect surveys focused in softwood habitat types such as cedar swamps, black spruce, and spruce-fir. More than 67 landbird species were recorded, including the following species of concern: yellow-bellied flycatcher, Canada warbler, blackburnian warbler, ovenbird, black-throated blue warbler, American redstart, black-throated green warbler, bay-breasted warbler, chestnut-sided warbler, northern parula, veery, purple finch, boreal chickadee, yellow-bellied sapsucker, eastern wood peewee, Cape May warbler, and ruffed grouse.

Mammals

Based upon known regional distributions and habitat requirements, the refuge supports approximately 50 different mammal species. At least 36 of those are confirmed on the refuge, including 7 types of shrews or moles, 4 bats, 10 rodents, and 12 carnivores, as well as moose, white-tailed deer, and snowshoe hare. Common carnivores include black bear, eastern coyote, red fox, fisher, and river otter.

An American marten at a bait station on the refuge

USFWS

For 3 years, we conducted limited field surveys of small mammal populations to establish baseline data for the refuge. The masked shrew was most frequently detected. We also initiated surveys of mid-sized carnivores, including fisher, marten, bobcat, and lynx (see lynx discussion below), using techniques such as snow tracking and photography at remote bait stations. From 2002 to 2004, we assembled seven camera bait stations around the refuge. Most were kept up for approximately 1 month in January or February, except for two sites on Sunday Cove, which were up from March to early June. Fisher were detected at five sites; marten at three sites; and, bobcat at one site. Coyote and short- and long-tailed weasel also have been observed on the refuge.

Moose, white-tailed deer, and beaver are common in the area of the refuge, and are known elsewhere to exert particularly strong influences on the local plant community, affecting both the composition and age structure of the forest. However, we do not have local information to that effect. No surveys for these species have been conducted on the refuge.

From 1992 to 1995, refuge staff mapped active beaver colonies along the Magalloway and Androscoggin rivers, the Mountain Pond drainage, and the north end of Umbagog Lake. The colonies mapped range from 6 to 11. That mapping predates any of the current staff. Records on the methodology the

survey used are lacking. It appears to have been an effort to characterize wildlife activity in the area of the refuge and begin collecting baseline data.

Lynx

Lynx are Federal-listed as Threatened. As mentioned above, we used camera bait and tracking surveys from 2002 to 2004 to detect small mammals and midsized carnivores such as lynx. We detected no lynx on the refuge, although their presence has been confirmed approximately 10 miles away in Magalloway Plantation, Maine. State lynx experts have told us that those occurrences are considered to be individuals dispersing from their breeding areas, since the closest confirmed breeding location in Maine is approximately 90 miles from the refuge (J. Vashon, MDIFW, personal communication, 2006). In New Hampshire, researchers discovered a lynx track in January 2006 along Route 2 in the town of Jefferson, approximately 45 miles southeast of the refuge (NHFG 2006).

Lynx are medium-sized cats that are adapted to life in deep, deep snow and are specialist predators on the snowshoe hare. Their adaptations to life in a typically boreal forest give them a competitive edge over such other species as bobcat and coyote. Northern New Hampshire is the southern edge of lynx habitat. Given their dependency on snowshoe hare, lynx must occupy large home ranges to ensure access to sufficient prey. Snowshoe hare are most abundant in forests with dense understory that provide forage, escape cover, and protection during extreme weather, and therefore, hare densities are generally higher in regenerating, earlier successional forest. Lynx also require lots of coarse woody debris, such as downed logs and windfalls, as safe den sites (Federal Register 2005).

In Maine, lynx use spruce-fir dominated regenerating stands that develop 15 to 30 years after forest disturbance. The Service has proposed more than 10,000 acres in Maine as "critical habitat." The refuge does not provide large areas of either the late- or the early seral conifer forest preferred by lynx, although refuge habitats may serve as dispersal habitat for lynx (Federal Register 2005). The Service has not proposed any areas as critical habitat solely because they provide habitat for dispersing animals.

White-tailed deer wintering areas

The NHFG and MDIFW identified many areas of lowland conifer forests on and near the refuge that provide critically important winter cover for white-tailed deer (map 2-10). Up to 100 deer are known to congregate in some of these areas on the refuge (Will Staats, NHFG, personal communication, 2003). Triggered to some extent by increasing snow depths, deer usually migrate to those areas in the late fall. Those areas are also important during periods of intense cold, even during snow free winters. The deer create a vast network of trails throughout the wintering area, traveling along those trails to search for food or escape predators.

Quality deer wintering habitat consists of two components and their proximity to each other: cover to protect the deer from the elements, and access to browse. Softwood stands (primarily spruce-fir) at least 35 feet tall with a crown closure that averages about 70 percent or more is ideal winter cover (Reay et al. 1990). Older, taller stands that are generally stronger provide the best cover-branch structure for intercepting snow. Those older stands often begin to develop gaps, which stimulate regeneration and provide browse for deer. Younger, denser stands are also desirable if they have small openings, about a quarter of an acre in size or less, so that the deer have access to browse and sunlight for warmth.

In the 1990s, MDIFW staff conducted aerial and ground surveys of Region D in Maine. Those surveys determined that Upton and Rangeley had the

most extensive wintering habitat for deer in the entire region, which includes 115 organized towns and townships (Chuck Hulsey, MDIFW, personal communication, 2006). Unregulated timber harvesting continues to threaten valuable winter shelter in Upton, which is strategically important to regional deer populations. The conservation of that habitat is of the highest importance for achieving deer population objectives set by public working groups (Chuck Hulsey, MDIFW, personal communications, 2006).

Fish
Based upon available local documentation and a list compiled by MDIFW, at least 24 fish species are present in water bodies on the refuge. Major changes in both the abundance and species composition of the Umbagog Lake fishery during the past 150 years have created a fishery today that bears very little resemblance to that present before the establishment of the first Errol Dam in the 1850s. During the 1800s, the lake supported a thriving brook trout population (Bonney, personal communication, 2002). Today, only portions of Umbagog Lake and the Rapid River support a native brook trout population.

Before 1900, however, Atlantic salmon, chain pickerel, rainbow smelt, brown bullhead, and several other species were introduced into the Androscoggin River or the Rangeley Lakes. Changes that are more recent include the introduction and subsequent population expansion of smallmouth bass, introduced into the lake in 1995. Northern pike have also been observed in the lake in recent years, but their present population status remains unclear (Bonney, personal communication).

Green frog

John Mosesso, Jr./NBII

Amphibians
Spring surveys of singing frogs (1999–2002) and stream surveys (2001–2002) have recorded 16 amphibian species on the refuge: seven salamanders, eight frogs, and one toad. Those include northern two-lined, northern red-backed, dusky, and spring salamander in or along streams. The fen and flooded meadows, peat lands, cedar swamps, and floodplains support diverse frogs and toads; the most common include bullfrog, green frog, spring peeper, American toad, and mink frog. Other species include northern leopard, pickerel, and wood frog. Blue-spotted and spotted salamanders and eastern newts were found in vernal pools in floodplains and cedar swamps.

Invertebrates
As part of a water quality study in 2003, 20 sites on Umbagog Lake, the lower Magalloway River, and the upper Androscoggin River were surveyed for aquatic macro-invertebrates (Van de Poll 2004). Van de Poll collected 120 taxa representing 14 classes, 28 orders, and 79 families of macro-invertebrates. No obvious indications of a reduction in community diversity or severe pollution were found. Some of the higher diversity sites for macro-invertebrates were the fringes of wetlands on the lake. The most groups of invertebrates collected were little pond snails and the shrimp-like scuds, followed by midges, mayflies, caddisflies, and beetles (Van de Poll 2004). We have not conducted any other invertebrate surveys.

Cultural and Historic Resources

Invasive Animals
We have not systematically surveyed for invasive terrestrial or aquatic animals. We are not aware of any invasive terrestrial animals on the refuge, and our primary concern about aquatic invasive species focuses on the many introduced fish species, such as smallmouth bass.

We have not conducted a detailed archeological and historic survey of all refuge lands. However, we have conducted some specific project surveys to determine further the eligibility of certain sites. In New Hampshire, we know of one historic

and three prehistoric archeological sites on refuge land. In Maine, we know of one prehistoric site on refuge land. We expect that a detailed, systematic survey would likely reveal many more sites that are prehistoric.

Several limited historical architectural surveys on the refuge determined that its buildings were not eligible for the National Register of Historic Places. In October 1992, the Maine SHPO concurred with our regional archeologist in finding the Stranger Farm ineligible. In 1993, our regional HPO determined that the Potter Farm, which includes a house and two outbuildings more than 50 years old, is ineligible, because they have been altered since their original construction. We forwarded that assessment to the New Hampshire SHPO but received no response, indicating tacit concurrence with the Service assessment. An associated cemetery, the Stone cemetery, lies on the private Kronck property, on which the Service owns an easement. In 1995, we also assessed and determined ineligible the now demolished Priest cabin. In 2004, our regional archeologist evaluated the cabins in the area of Chapel Hill Road, and determined none eligible. We have forwarded that assessment to the New Hampshire SHPO, and are awaiting their response.

We have not surveyed other cabins, several more than 50 years old, on refuge lands. The Service may acquire more cabins with future acquisitions.

The refuge has only a few archaeological artifacts for museum property. They are stored in the Regional Office. There are no important museum property issues at the refuge (D.H. Hurd and Company 1982; Dobbs and Ober 1995).

Priority Public Uses

We describe below current opportunities on the refuge for engaging in the six priority public uses of the Refuge System Improvement Act: hunting, fishing, wildlife observation and photography, and environmental education and interpretation.

The refuge area is a very popular destination, especially for water recreation. Many visitors return year after year. Refuge lands provide year-round activities; the most popular include motor boating, canoeing, kayaking, remote lake camping, observing and photographing wildlife, hunting, and snowmobiling. All activities are allowed from half an hour before sunrise to half an hour after sunset, with the exception of camping in designated sites on designated days, which provides for overnight use. The waters in and around the refuge undergo the most recreational pressure during the summer (USFWS 2000b).

We have not conducted formal surveys of annual refuge visitation, despite their desirability. Limited funding and staffing, numerous access points, and the confusion of many visitors about whether they are on refuge or state lands have proved challenging. However, for the purposes of this CCP/EIS, we have estimated annual visitation based on a variety of sources, including visitor contacts at refuge headquarters, boat activity surveys between 2000 and 2004, reservations for the duck hunting blinds, and general observations by refuge and state agency personnel. We estimate our total annual visitation at approximately 49,500 visitors over the last 5 years. Most visitors are non-local residents. Appendix G, table G.6, summarizes our 15-year projection of visitation by activity.

Hunting

After completing a refuge Hunt Plan, we opened the refuge officially in fall 2000 for hunting for waterfowl, migratory game birds, upland game and big game. We amended that Hunt Plan, and its accompanying EA, most recently in April 2007. Alternative 2 in that EA represents our current program. The objectives of the hunt program include providing the public with a safe, high-quality recreational experience, providing an opportunity to utilize a renewable natural resource, and

providing a tool to help maintain wildlife populations at levels within the carrying capacity of their habitat (USFWS, 2007). We estimate 5,650 hunter visits on refuge lands annually. The refuge lies in New Hampshire Wildlife Management Units (WMU) A and WMU C2, and Maine WMU 7.

All federal and the respective state hunting regulations apply, including seasons, bag limits and license requirements, along with additional, special refuge regulations (listed in 50 C.F.R. 32 sub-part B). The only exceptions to state regulations are that we do not currently allow turkey hunting on refuge lands and we do not allow bobcat hunting in Maine. Since the New Hampshire-Maine state line crosses the refuge, hunters are responsible for knowing which state they are in and hunting according to the regulations for that state. Hunting seasons generally are between early September and the end of March. No refuge permits are required, and no fees are charged. Enforcement is primarily by the respective state game wardens. The most commonly hunted species in and around the refuge are waterfowl, ruffed grouse, woodcock, moose, white-tailed deer, and snowshoe hare.

In 1999, we instituted a waterfowl blind reservations system allowing hunters to sign up on a first-come, first-served basis for one of six permanent waterfowl blinds on refuge waters (map 3-2). We do not have quantitative data on harvest levels, but hunters using blinds have recorded harvest of: black duck, mallard, common merganser, Canada goose, wood and ring-necked duck, blue-winged and green-winged teal, scaup, bufflehead, and Wilson's snipe.

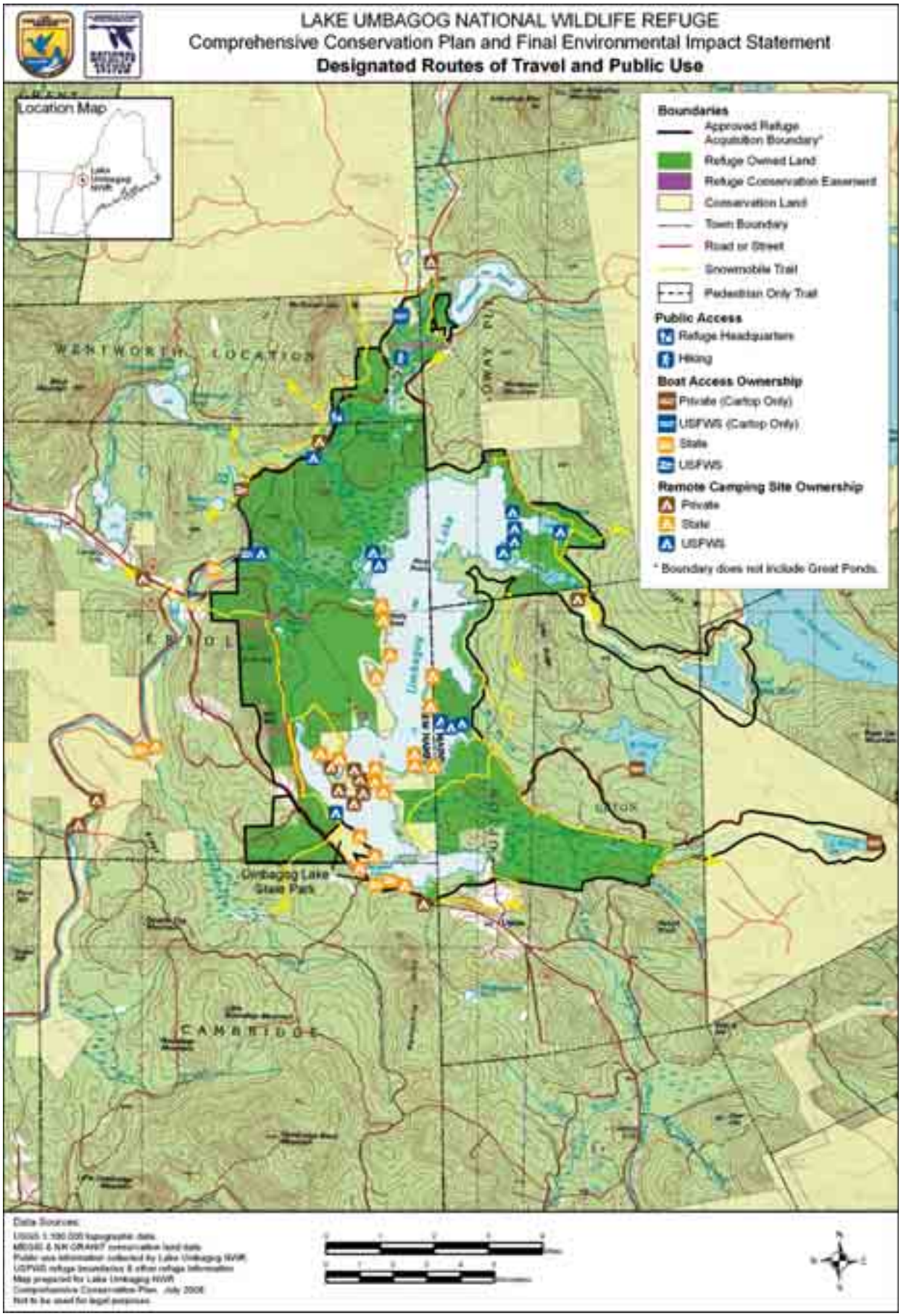
Harvest levels have not been determined for any mammal or upland game bird species taken from the refuge. However, NHFG and MDIFW data from both of the respective WMUs or associated townships provides some information on harvest rates. The refuge represents only a very small proportion of each WMU, 2.12% of WMU's in New Hampshire, and 0.57% of WMU 7 in Maine, and therefore, only a very small proportion of the reported harvest would be considered as coming directly from refuge lands. In 2004, New Hampshire deer harvest rates for the townships of Cambridge, Errol, and Wentworth Location were 0.41 deer/sq mile; 0.39 deer/sq mile, and 0.36 deer/sq mile, respectively. In Maine, deer harvest rates for WMU 7 were reported to be 0.37 deer/sq mile.

Also in 2004, 4 bear and 34 moose were taken in the township of Errol. In Maine's WMU 7, 198 bear and 112 moose were taken. Of the 198 bear taken, only 31 were taken using methods allowed on the refuge. In addition, 26 turkeys were harvested in New Hampshire's WMU C2, but only four were taken in towns next to the refuge.

Fishing

We have not officially opened refuge lands to fishing, but we plan to do so after completing the CCP. Most anglers who visit our area want to fish on the lake and in other state waters; fishing from the lake's shoreline is less popular. We estimate approximately 11,000 visitors per year are fishing on the refuge or accessing lake fishing through the refuge. We currently provide access to these state waters via several boat landings (map 3-2). Our primary concern about current fishing activities arises when anglers access sensitive resource areas administratively closed, such as the eagle, osprey, and loon nesting sites.

Fishing from boats on Umbagog Lake and its tributary rivers falls under state jurisdiction, and state regulations apply for seasons, creel limits, and license requirements. Licensed New Hampshire or Maine anglers may fish any part of the lake with their license, and certain sections of the rivers, including the Androscoggin River upstream of the Errol Dam and the Magalloway River within New Hampshire, and on the Rapid River in Maine upstream to the marker at Cedar Stump.


LAKE UMBAGOG NATIONAL WILDLIFE REFUGE
Comprehensive Conservation Plan and Final Environmental Impact Statement
Designated Routes of Travel and Public Use
Location Map
Boundaries
Approved Refuge Acquisition Boundary*
Refuge Owned Land
Refuge Conservation Easement
Conservation Land
Town Boundary
Road or Street
Snowmobile Trail
Pedestrian Only Trail
Public Access
Refuge Headquarters
Hiking
Boat Access Ownership
Private (Cartop Only)
USFWS (Cartop Only)
State
USFWS
Remote Camping Site Ownership
Private
State
USFWS
* Boundary does not include Great Ponds.
WENTWORTH LOCATION
ERROL
CAMBRIDGE
Umbagog Lake State Park
Data Sources:
Not to be used for legal purposes.

Anglers fish Umbagog Lake for a variety of both cold and warm water species. The most popular are smallmouth and largemouth bass, landlocked salmon, brook trout, and lake trout. Local streams and rivers, (e.g., the Magalloway, Androscoggin, and Rapid rivers), are also noted for their excellent fly-fishing opportunities.

The abundant, well-established population of smallmouth bass illegally introduced into the lake in the mid-1980s recently colonized the Rapid River as far as Pond-in-the-River, and are now a concern among state agencies managing the native brook trout. Since that introduction, the number of bass boats on the lake has increased, and bass tournaments there have become increasingly popular. The State of Maine sets restrictions on those tournaments to allow only one permit on a water body for a specific date, no tournaments until June 15, five tournaments annually on water bodies greater than 3,500 acres, and a maximum of 100 boats per tournament.

Ice fishing is also becoming increasingly popular, and ice-fishing camps appear on the lake throughout the winter, primarily on state jurisdiction. Although fishing remains popular, mercury contamination throughout the region has led to recommendations on limiting fish consumption (NH DES 2004). Mercury deposition affects all of the freshwater lakes in New Hampshire and Maine, not just Umbagog Lake (NH DES 2004; MDEP 2004).

Observing wildlife on the refuge

USFWS

Wildlife Observation and Nature Photography
Wildlife observation and nature photography are major attractions in the Umbagog Lake area, and we have noticed public participation increasing over the past 5 years. Loon, bald eagle, and moose are the major viewing attractions, as are bird watching and leaf peeping in general. We allow access by foot, snowshoe, cross-country ski, and motorized or non-motorized boat. We estimate that 18,500 visitors annually engage in viewing and photographing wildlife on the refuge.

We maintain one trail, the Magalloway River Trail; accessed off Route 16 approximately 2 miles north of refuge headquarters (map 3-2). The trail follows a gravel road built for a proposed subdivision cul-de-sac, and is now part of the refuge in an area known as the "Day Flats." That area supports a major moose wallow, and has the potential for restoration to a wooded wetland habitat. It is approximately one-third of a mile long, and has a viewing platform at its end that overlooks a backwater oxbow in the river. We plan a quarter-mile loop extension of that trail for 2006.

Interpretation and Environmental Education
Our staff conduct interpretive programs as funding and staff time allow, typically about three each year. The demand for programs from local schools, scouting, and other groups far exceeds our ability to provide them. A limited amount of interpretive literature (e.g., handouts or brochures) is available from displays at the refuge headquarters.

We participate in two very popular outreach events each year: the Wildlife Festival and the "Take Me Fishing" Day. Since 1997, our staff and the Umbagog Chamber of Commerce have sponsored the annual Wildlife Festival in Errol in early August. More than 300 people have attended this event in some years. The "Take Me Fishing" event, also held in August, recently was combined with the Wildlife Festival on the same day. The fishing event is also offered in cooperation with the Umbagog Chamber of Commerce, as well as Orvis, Shakespeare, and other local companies, and is held at the Potter Farm. Up to 50 people have participated in that fishing event in a given year.

We have not developed a curriculum for environmental education programs. We have been involved in fulfilling requests from teachers at local schools to provide programs that supplement their curriculum. Generally, one or two school programs are given in a given year.

We have regularly supported college interns: namely, graduate students from Vermont and New Hampshire universities who seek on-the-job experience while achieving college credit. They have completed a variety of projects: namely, research on habitat and species of concern to us.

Remote Camping on Umbagog Lake
The State of New Hampshire operates the Umbagog Lake state campground at the southern end of the lake: 37 developed shoreline sites and 30 remote lake camping sites in various locations on the lake (map 3-2). Twelve of the remote lake sites are located on refuge land. A cooperative agreement between the NHDRED and the Service will formalize the administration of those sites. They are a very population destination, and typically are full to capacity in July and August, and often into September. A 3-year average from 2001 to 2003 showed 4,700 campers in July and 5,347 for August. Overall, use has declined in recent years, but only because several sites were closed to retain the remote backcountry quality of the camping facilities (New Hampshire Division of Parks and Recreation 2004). Two other river camp sites (North 1 and North 2) occur on refuge lands but their removal and restoration is planned. In addition to the state park, other private campgrounds with facilities are available in the surrounding area.

Boating
One improved and two unimproved public boat launch sites along the Magalloway River are on refuge land (upper Magalloway River car-top launch, a launch at refuge headquarters, and one at Parson's landing (map 3-2). One other launch site exists on refuge land on the Androscoggin River, above the Errol Dam (Steamer Diamond landing). The launch at Parson's landing has been heavily impacted,and is therefore, planned for closure. Improved launch sites are also located off refuge land near the Errol Dam on the Androscoggin River and at the south end of Umbagog Lake, at Umbagog State Park. The park rents boats and motors, and offers pontoon boat tours of the lake. The State of Maine requires that all motorized watercraft on inland waters, including Umbagog Lake, display a "Lake and River Protection" sticker.

We estimate that 14,000 visitors are boating on refuge waters, mostly in conjunction with viewing and photographing wildlife and fishing. Rough estimates by our interns in June and July indicate that the use of motorized boats and canoes or kayaks were roughly equal from 2000 through 2004. However, we have observed a rapid increase in motorized boating over the past few years, much of it attributed to bass fishing. A much smaller percentage of jet skis, sailboats, and pontoon boats are used on the lake.

The Androscoggin River, Umbagog Lake, and the Rapid River are highlighted as part of the Northern Forest Canoe Trail. That trail extends 740 miles from Old Forge, New York, to Fort Kent, Maine. At least six local outfitters and campgrounds offer canoe and kayak rentals and guided canoe or kayak tours of the lake, and some offer paddling instruction on the lake and in surrounding rivers and streams. College, school, and summer camp groups also use the lake for paddling trips. Canoe and kayak use has increased dramatically.

Snowmobiling
Snowmobiling is another activity we have observed increasing markedly on refuge and surrounding lands in recent years. With hundreds of miles of groomed

snowmobile trails, the Umbagog Lake area is very popular and local businesses target this audience through advertisements (Umbagog Chamber of Commerce 2005). It is a significant economic activity for the area during winter.

We estimate 20,000 snowmobile visits occur each year on refuge lands as part of a regional trail system (Gray, New Hampshire Bureau of Trails, personal communication, 2005). Snowmobile use on the refuge is permitted on designated trails only. Map 3-2 depicts trail locations authorized by the refuge manager on the refuge in both New Hampshire and Maine. Unfortunately, several unauthorized spur trails on the refuge are an enforcement issue.

Snowmobiling on the refuge

Marvin Moriarty/USFWS

Certain activities evaluated by the refuge manager were determined not to be appropriate on refuge lands including: ATV, ORV and dirtbike use, competitions or organized competitive group events (e.g. fishing derbies, dog trials, or bicycling, and cross-country skiing), and geocaching. Appendix C includes negative findings of appropriateness. which document the refuge manager's rationale.

Furbearer Trapping
The refuge is not open for trapping. However, we suspect that beaver trapping is occurring in some areas of the refuge. The NHFG and MDIFW have asked us to open refuge lands to furbearer trapping consistent with their respective state seasons. Those agencies maintain that trapping is a traditional, historic use in the area, was established well before the refuge was created, and was allowed by previous owners. They also promote trapping as a wildlife-dependent activity that is an effective tool for managing furbearer populations.

Off-road Vehicle Use
ORV and ATV use is not allowed on the refuge except by special use permit on a case-by-case basis to allow hunters with disabilities reasonable access to hunt and retrieve their game.

We have been involved in many partnerships since refuge establishment, which would not have been possible without the cooperation of the states of New Hampshire and Maine, timber companies, conservation organizations, private landowners, local elected officials, and town and county community leaders. Those partners continue to be active in land conservation for the common goal of maintaining the aesthetic, cultural, economic, and ecological values of the region for future generations.

Our partnerships continue to expand to include not only groups and individuals interested in land conservation, but also those interested in habitat and species management, recreation and visitor services, and education and public outreach. A list of our current partners follows.

Conservation organizations: Trust for Public Lands, TNC, ASNH, Loon Preservation Committee, New England Forestry Foundation, Mahoosic Land Trust, Society for the Protection of New Hampshire Forests, Androscoggin Watershed Council, Rangeley Lakes Heritage Trust, The Conservation Fund, Trout Unlimited;

Town and County Governments: Towns of Errol, Upton, Magalloway Plantation, and Coos County;

State agencies: NHFG, MDIFW, NHDRED, New Hampshire Office of Energy and Planning;

Private companies: FPLE, Wagner Forest Management; and,

Universities and other educational institutions and organizations: Dartmouth College, University of Vermont, University of Massachusetts, Hurricane Island Outward Bound, The Chewonki Foundation, and the Northwoods Stewardship Center.

Friends Group
The Friends of Umbagog National Wildlife Refuge assist in the development and implementation of interpretive programs and tours on the refuge. Members also participate in the annual Wildlife Festival and Take-Me-Fishing events. They are invaluable in supporting those priority programs and helping us respond to the requests for progras that far exceed our ability to meet them.

Volunteer Programs
Our active volunteer program involves student interns from all over the country, as well as local residents, clubs, and organizations.

Every summer and fall, we host three to four volunteer student interns, who are generally college-aged students or recent graduates. Interns spend 10 to 12 weeks assisting with various refuge projects in return for housing and a small stipend. Their duties include working on maintenance, collecting biological data, monitoring public use, leading nature walks and interpretive programs, helping with the Wildlife Festival and Fishing event, monitoring public use, designing educational displays, greeting the public, and maintaining the refuge GIS system.

Four or five volunteers, generally local or from elsewhere in New Hampshire, assist us each spring in surveying land birds, marsh birds, and shorebirds. Ten to 25 volunteers assist the refuge each year at the Wildlife Festival. Volunteers run information booths and lead birding tours (by canoes, pontoon boats, or walks). They also spend a day helping with various refuge projects. Past projects have included cleaning up the refuge and surveying for waterfowl broods, ospreys, eagles, and other raptors.

Five volunteer local anglers assisted with the first Take Me Fishing event in 2002. They set up displays, demonstrated fly-tying and fly-casting, and guided fishing trips on the lake.

Several organizations bring volunteer youth groups to perform service work on the refuge each summer. Those include Hurricane Outward Bound, The Chewonki Foundation, and the Vermont Leadership Center. Past projects have included clearing trails, building fences, and painting, assisting in biological surveys, and restoring campsites. Group sizes average from 5 to 10 volunteers.

Every year, anywhere from two to five individuals contact us to volunteer their help for one or more days. In the past, those volunteers have assisted with maintenance, biological surveys, public outreach and visitor services, the design of an interpretive trail, clerical work, and research. The duration of the work has varied from just a few hours up to 2 months. We provide housing for volunteers who contribute more than one day and come from locations that are more distant.

Youth Conservation Corps Program
We also host a YCC summer program, typically for 4 to 5 youth between the ages of 14 and 18. An adult coordinator is also hired to supervise them. The YCC program includes an environmental educational component in addition to their paid work assisting with refuge studies, facilities maintenance, and other activities. This is a popular program in the area, as summer outdoor employment for youth is limited.

Youth Conservation Corps crew on the refuge

Ian Drew/USFWS